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TECHNICAL REPORT
EP-77

CLIMATIC ANALOGS OF FORT GREELY, ALASKA, AND FORT CHURCHILL, CANADA, IN EURASIA

QUARTERMASTER RESEARCH & ENGINEERING CENTER
ENVIRONMENTAL PROTECTION RESEARCH DIVISION

DECEMBER 1957 NATICK, MASSACHUSETTS

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OFFICE OF THE COMMANDING GENERAL
NATICK, MASSACHUSETTS

Major General Andrew T. McNamara
The Quartermaster General
Washington 25, D. C.

Dear General McNamara:

This report, "Climatic Analogs of Fort Greely, Alaska, and Fort Churchill, Canada, in Eurasia", delimits, within the Eurasian continent, the land areas whose climates are similar to those of the two Department of the Army cold weather test sites.

It was determined that relatively large areas have climatic conditions analogous to those of the test sites when only single climatic elements are considered. Simultaneous consideration of several elements, such as summer and winter temperatures and annual precipitation, reduces the size of the areas climatically analogous to the test sites.

The results of this study provide a realistic basis for determining the representativeness of the climate of the test sites. The study will prove useful to test and design personnel in that it delimits areas where items tested in the climates of the test sites can be expected to operate satisfactorily. The report also indicates areas having a more extreme climate than that of the test sites, information that should be considered when designing equipment intended for use in extreme cold environments.

Sincerely yours,

C. G. Calloway

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C. G. CALLOWAY
Major General, USA
Commanding

HEADQUARTERS QUARTERMASTER RESEARCH & ENGINEERING COMMAND, US ARMY
Quartermaster Research & Engineering Center
Natick, Massachusetts

ENVIRONMENTAL PROTECTION RESEARCH DIVISION

Technical Report
EP-77

CLIMATIC ANALOGS OF FORT GREELY, ALASKA, AND FORT CHURCHILL, CANADA, IN EURASIA

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REGIONAL ENVIRONMENTS RESEARCH BRANCH

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Foreword

This report is one of a series designed to determine the extent of world areas having climates similar to those of the various Department of the Army test sites. The present study compares climatic conditions at Fort Greely, Alaska, and Fort Churchill, Canada with those of the Eurasian arctic and subarctic.

The series of climatic analog studies, prepared at the request of the U.S. Army Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi, is part of a program for evaluating the suitability and representativeness of all Department of the Army test sites. They constitute the Quartermaster Corps contribution to the Corps of Engineers project on "Military Evaluation of Geographic Areas."

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Abstract

Climatic conditions at Fort Greely, Alaska, and Fort Churchill, Canada, are compared with the climates of arctic and subarctic regions in Eurasia. The climatic elements are treated in the discussion, and maps are included to present pictorially the distribution of analogous conditions.

The cold region around the "cold pole" of Siberia, in the vicinity of Verkhoyansk, is too cold for analogy to either test site. Mean temperatures for the coldest month are analogous to those of Fort Churchill in a relatively narrow band encircling this region. Coldest month temperatures analogous to those of Fort Greely, the warmer of the two test sites, are found in a second, outer band around the Siberian core region of extreme cold.

Only very limited areas are found where both temperature and windchill conditions are analogous. Areas analogous to Fort Greely are confined principally to northern and eastern Novaya Zemlya and to the coastal areas bordering the southern part of the Kara Sea. Windchill and temperature conditions analogous to those of Fort Churchill during the coldest month are best defined in the northern lowlands between the Ob and Yenisey Rivers and along the Arctic coast from the Yenisey to the Lena River.

Combined summer-winter temperatures and annual precipitation analogy to Fort Greely exists only in the northern part of the Central Russian Tableland and adjoining parts of the West Siberian Lowland. The northern part of the West Siberian Lowland and the Arctic Lowlands to the north receive annual precipitation amounts and have summer-winter temperatures analogous to those at Fort Churchill. Larger areas are indicated where annual precipitation combined with either summer or winter temperatures is analogous to the test sites.

CLIMATIC ANALOGS OF FORT GREELY, ALASKA, AND FORT CHURCHILL, CANADA, IN EURASIA

1. Introduction

This study was prepared in answer to a request from the Office, Chief of Engineers, for a climatic comparison of Fort Greely, Alaska, and Fort Churchill, Canada, Department of the Army cold-weather test sites, with other arctic and subarctic regions. The present study covers Eurasia north of latitude 45°N. (see Figure 1). A subsequent report will cover the arctic and subarctic areas of the Western Hemisphere.

Only those climatic elements that most adequately define stress factors in cold environments have been selected for study. For each selected element a map has been prepared depicting areas having conditions regarded as analogous to those at Fort Greely and Fort Churchill. Information from certain of these maps has been consolidated on a single composite map to show areas of coincidence of analogous elements.

Climatic conditions at Fort Greely and Fort Churchill have been summarized by the Environmental Protection Research Division, in the following publications:

Frequency and Duration of Low Temperature at Fort Churchill, Manitoba, Canada, Technical Report EP-2[5]

Handbook of Fort Churchill Environment, Technical Report EP-4[6]

Handbook of Big Delta,* Alaska, Environment, Technical Report EP-5[7]

Data from these studies serve as the basis for comparison in this report.

2. Major Physical Features (Fig. 2)

The Eurasia study area consists of the Arctic and subarctic as defined by Washburn [16] and the adjoining areas lying north of 45°N latitude. According to Washburn's criteria, the Arctic consists of those areas north of the 50°F isotherm for the warmest month and where the mean temperature of the coldest month is 32°F or lower; subarctic lands consist of those areas where the mean temperature is higher than 50°F for not more than four months of the year and where the mean temperature of the coldest month is 32°F or lower. In order to include most of the area of the continents having a summer analogy of one or more climatic elements, the study area was extended southward to 45°N latitude. Thus it includes Scandinavia and central Europe, most of the

*Renamed Fort Greely in August, 1955.

USSR and arctic islands off its coast, and a large part of Outer Mongolia and Manchuria.

In Europe, most of the study area lies below 1,000 feet in elevation. The central plains of Europe extend eastward from the Paris Basin as the Baltic Plain, eventually joining the Central Russian Tableland. In the south, the European plains are bordered by the Alps, the highest mountain chain in Europe, with many peaks exceeding 10,000 feet. This system extends from southern France into southeastern Austria. Farther east, the Alps join a smaller mountain system that includes the Transylvanian Alps and the Carpathian Mountains. This system has heights considerably lower than the main ridge of the European Alps.

In the north, the principal highland areas are the Norwegian Highlands which form the "backbone" of the Scandinavian Peninsula. This mountain system is oriented in a southwest-northeast direction, and its highest peaks, located on the west coast, rarely exceed 7,000 feet.

The USSR, a major part of the study area, consists essentially of a large lowland north of the east-west mountain and plateau belt which extends across the continent. European Russia is predominantly a low rolling plain with an average elevation of less than 600 feet and maximum elevations which do not usually exceed 1,500 feet. In the southeast, this plain merges into the Caspian Depression which contains the lowest land areas of the Soviet Union. The Ural Mountains, averaging 1,600 feet in elevation, border the Central Russian Tableland on the east and separate it from the vast flat areas of the West Siberian Lowland. The Urals extend approximately north-south from the Arctic seacoast to the southern steppes. In the north, elevations range from about 2,000 to slightly less than 6,200 feet, the highest peak, Mt. Narodnaia, reaching an elevation of 6,183 feet. The middle Urals are generally lower than those in the north or south, and have been described as little more than hills. It is here that most rail lines and roads cross the mountains. In the southern Urals, elevations increase again, and the highest mountain, Yaman-Tau, has an elevation of 5,375 feet.

East of the Urals, the West Siberian Lowlands extend into eastern Siberia above 70°N latitude. About 90 percent of western Siberia consists of gently sloping plain, stretching from the Urals to the Yenisey River in the east and from the Arctic to the Altai Mountain system in the southeast. The highest portion of the Altai system has average elevations ranging from 11,400 to 15,000 feet. This mountain system is the source of the Ob and Irtysh Rivers, the principal streams of the West Siberian Plain.

From the Yenisey River east to the Pacific Ocean lies a region of plateaus and mountains. The Central Siberian Plateau, lying between the Yenisey and Lena Rivers, occupies the greater portion of eastern Siberia. The average elevation of this plateau is below 1500 feet, but occasional heights of 3,000 feet are found near the center. To the south, the Central Siberian Plateau is bordered by the Sayan-Baykal and the Transbaykal Mountain systems and the Stanovoy Range, which comprise the major part of the Central Asiatic Block Mountains. The highest peak, Mun Ku-Sardyk in the Sayan Mountains, reaches 11,500 feet.

In Northeastern Siberia, the Verkhoyansk Range and the East Siberian Highlands enclose lowlands which open north to the Arctic Ocean. Other mountain ranges extend along Sakhalin Island (north of Japan) and the Kamchatka Peninsula.

The Amur Region, in the extreme southeast of the USSR, lies between the Stanovoy range in the north and the Amur River to the south, and extends to the Bureya range in the east. The area is a plateau, which slopes southward to the Amur River. The Sikhotin-Alin mountains, with some peaks reaching nearly 13,000 feet, extend along the coast south of the Amur River.

3. Climate

The climates in the study area are controlled by the extent and topography of the land masses, the distribution of adjacent cold or warm water currents, the seasonal pressure distribution, and the seasonal and areal variation in solar radiation.

In western Europe, maritime air masses dominate the weather most of the year. The climate is mild, due to maritime exposure and the absence of a north-south mountain barrier which permit relatively warm and moist air masses from the Atlantic Ocean to penetrate far inland. The warm areas to the south are separated from the cooler northern areas by the east-west mountain chains of southern Europe. Inland, the marine influence is less pronounced, and central Europe may be considered a broad transitional zone between the mild maritime climate to the west and the continental type to the east. In Scandinavia, this zone of maritime influence is narrow. The climate of the coast of Norway is mild, due to the proximity of the warm North Atlantic drift (Gulf Stream), but the coastal mountains of Norway serve as a barrier restricting the penetration of warm air inland for any great distance. As a consequence, away from the coast, temperatures fall rapidly, resulting in a much more severe climate in eastern Norway and Sweden.

The climate of eastern Europe and European Russia is dominated in winter by the circulation associated with the semi-permanent high pressure area over the continent, and in summer by a thermal low caused by solar heating. The climate is not as severe as that of Siberia because of the incursion of modified maritime air masses into the area. East of the Yenisey River this westerly oceanic influence is negligible.

The climate of Siberia is influenced by the vast land mass of Eurasia and by the ring of high mountains and plateaus to the south and east that prevent the invasion of moist, warm, moderating air masses. Arctic and polar air masses penetrate deeply into the interior because there is no east-west terrain barrier to the north. Relatively clear skies and the absence of moist air and strong winds present ideal conditions for radiational cooling. As a consequence, the interior of Siberia has one of the world's most continental climates, characterized by extremely cold winters.

The influence of the Pacific Ocean is confined to a narrow coastal strip south of the mouth of the Amur River and to the extreme northeastern part of Siberia. In winter, the coastal regions bordering the Arctic Ocean are warmer than the interior because of proximity to a large body of water which, even though frozen, is warmer than the interior of the continent.

4. Analysis of Climatic Elements

The climatic elements for which maps have been prepared are those which impose stress on men and equipment in a cold environment, or are significant when comparing climates in the Arctic and subarctic. The series (see end of the report) includes maps of the mean and mean daily minimum temperatures for the coldest month; absolute minimum temperatures; mean and mean daily maximum temperatures for the warmest month; absolute maximum temperatures; mean annual precipitation; mean snow depth for the month of maximum depth; mean windchill for the coldest month; mean cloudiness for the coldest and warmest months, and mean annual frequency of fog.

On all maps, colored overprints are used to indicate areas closely analogous to Fort Churchill (blue) and Fort Greely (yellow). Semianalogy is indicated by symbols in the station circles.

All stations utilized in the analysis are shown on the station location map (Fig. 1). On individual maps, only those stations are indicated from which data were utilized in the analysis of that particular map. The distribution of stations varies, depending on the availability of data for the climatic element being analyzed. Since data are sparse or lacking for large portions of the region, the delimitations of analogous conditions in these areas must be regarded as approximate. In the analysis of the maps, mountain areas were considered, but no attempt was made to allow for the more intricate complexities introduced by them. The maps are intended to provide only a generalized picture of analogous and semianalogous areas based on the distribution of the more important climatic elements.

a. Mean Temperature, Coldest Month (Fig. 3)

Fort Greely: -5°F., January
Fort Churchill: -19°F., January

The standard deviation of the monthly mean temperatures was considered in determining the range for mean temperature analogy(1). It was decided to use a range of mean temperatures within which the average temperature of a single January could be expected to occur in half the years. For Fort Churchill, which has a standard deviation of 7F° for the January mean, a range of plus or minus 4.9F° from the long-term January mean results in the desired expectancy of 50 percent. For Fort Greely, which has a standard deviation of about 9F°, the range resulting in an expectancy of 50 percent equals plus or minus 6.5F° from the long-term mean. It was decided that a 5F° range on either side of the long-term mean, as used in previous studies of other environments, would be a sufficiently close approximation of these values.

In the discussion of climate it was shown that there is a gradual change in climate from west to east. This fact is well indicated by the positions of the analogous areas in Figure 3. Perhaps the most striking feature of the map is the large portion of central and eastern Siberia, in which mean temperatures are much lower than those at either test site.

The area analogous to Fort Churchill, the colder of the two test sites, encircles the central cold region in a relatively narrow band. It includes those portions of the Arctic coast having the greatest exposure to the warming effect of the ocean. The area broadens slightly in the west to include most of the West Siberian Lowland lying north of about 62°N. latitude and east of the Ob River. The influence of the Pacific Ocean and Okhotsk Sea does not extend far inland, as is evidenced by the narrowness of the analogous area along the east coast.

The area analogous to Fort Greely lies in another band encircling the area analogous to Fort Churchill and separated from it by a narrow band in which temperatures are semianalogous to those of both test sites. The analogous area includes Franz Josef Land and Novaya Zemlya in the Arctic Ocean, but excludes most of the Arctic coast. The total land area in the study region analogous to Fort Greely is about twice as large as that analogous to Fort Churchill.

b. <u>Mean Daily Minimum Temperature, Coldest Month (Fig. 4)</u>

Fort Greely: -13°F., January
Fort Churchill: -27°F., January

Areas having mean daily minimum temperature with a range of plus or minus 5F° from the mean values are considered analogous, and are designated by the colored shading on the map. Areas with analogous mean daily minimum temperatures approximate closely those with analogous mean temperatures of the coldest month (Fig. 3). For the greater part of the region, lowest minimum temperatures occur in January. Near the coasts, temperatures fall less rapidly through fall and early winter, due to retention of heat by the water and conduction through the ice. As a result, lowest mean daily minimum temperatures do not occur until February or even March at coastal locations.

Much of the interior of Siberia experiences temperatures considerably lower than those at either Fort Churchill or Fort Greely. Cold air accumulates over the interior, due to nocturnal (radiational) cooling during long, clear arctic nights. Extremely low temperatures are common in winter, especially in valleys and lowlands.

Many of the arctic coastal stations in the area analogous to Fort Churchill have mean daily minimum temperatures within 2F° of the Fort Churchill value. Temperatures decrease rapidly in the nonanalogous areas with increasing distance from the Arctic Ocean and its moderating influence.

c. Absolute Minimum Temperature (Fig. 5)

Fort Greely: -65°F., January
Fort Churchill: -57°F., January

Figure 5 shows the lowest temperatures reported for stations in the study area. Where available, lengths of record are indicated by subscripts to the temperature values. Use of short period records was confined to a minimum when analyzing the data, since lower values for absolute minimum temperatures are likely to occur with a longer record.

The analogous areas, based on a plus or minus 5F° temperature range, surround a large part of interior Siberia which has absolute temperatures much lower than those of either test site. In this region, temperature inversions and air drainage down mountain slopes are common. On cloudless nights that are free of wind, valley temperatures are much lower than those of adjacent mountains. Verkhoyansk and Oymyekon, near the "cold pole" of the Eastern Hemisphere, had the world's lowest official absolute minimum temperature, -90°F., until the record was broken in the Antarctic in 1957 (-102.1, South Pole). Other lowland stations in the region have absolute minimum temperatures between -70°F and -84°F.

The area analogous to Fort Churchill extends west over the northern part of the Ural Mountains into European Russia, and a second, smaller analogous area is centered over the interior of northern Finland. Low temperatures in European Russia are usually the result of the extension of a high pressure area over western Siberia. Nighttime radiational cooling often intensifies the actual temperature drop so that extreme low temperatures occur some time after the invasion of a cold air mass.

d. Mean Windchill, Coldest Month (Fig. 6)

Fort Greely: 1,630 Kg. Cal/m^2/hr., January
Fort Churchill: 1,820 Kg. Cal/m^2/hr., January

Windchill is a measure of the cooling effect of air movement on the human body. In this study, its computation is based on an empirical formula determined by Siple and Passel (38) from experiments conducted in the Antarctic in 1940. The following formula is used to compute the cooling effect H, of wind speed V (meters per second) and temperature t (Centigrade) in kilogram calories per square meter of exposed skin surface per hour per Centigrade degree of temperature difference between the skin surface and the air:

$$H = (\sqrt{100V} + 10.45 - V) (33-t)$$

The formula applies best to simultaneous conditions of wind and temperature, and use of average conditions in computing values gives slightly different results (Court (4), Falkowski (9)). However, these values are considered sufficiently representative to afford a qualitative measure of the relative severity of combinations of wind and low temperatures in the study area.

Mean windchill values for the test sites and stations in the study area were taken from the "Windchill Nomogram", prepared in 1943 by scientists of the Office of The Quartermaster General. Part of this nomogram is reproduced as an insert on Figure 6.

Ranges of analogy for the windchill factor were determined by the ranges of temperature and wind speed analogy. The mean wind speed at Fort Greely in January is 17 mph. Wind speeds in the range from 15 to 19 mph were considered analogous. These values for mean wind speed occurring within the range of mean temperature analogy (0° to -10°F) result in windchill values of from 1,500 to 1,760 kilogram calories per square meter per hour (see nomogram insert in Fig. 6). At Fort Churchill, the mean wind speed for the coldest month is 15 mph, and wind speeds from 13 to 17 mph were considered analogous. Close analogy of windchill includes values from 1,690 through 1,950 kilogram calories per square meter per hour. Values plotted beside the station symbols on the windchill map indicate the windchill as numerator and the wind speed as denominator. The mapped areas of analogy are based only on the windchill factor.

Owing to lesser wind speeds, windchill in most of the Siberian interior is less extreme than at Fort Churchill or Fort Greely, even though winter temperatures are much lower. Windchill is greatest on the Arctic coast of Siberia. This area has windchill factors closely analogous to those of Fort Churchill. Windchill factors closely analogous to that of Fort Greely are found in a comparatively large area north of the 62° parallel in Siberia and along a coastal strip bordering the Okhotsk Sea.

e. Mean Cloudiness, Coldest Month (Fig. 7)

Fort Greely: 5.5 tenths of sky covered, January
Fort Churchill: 4.7 tenths of sky covered, January

Europe has marked cloudiness in the coldest month and a larger mean value than either Fort Greely or Fort Churchill. This cloudiness is associated with low pressure and frontal system activity in western Europe. Cloudiness decreases eastward due to the blocking effects of the winter anticyclone and to the modification of air masses as they move across the continent. In most of Siberia, cloudiness is at a minimum in winter and more analogous to the test sites, due to the very dry air masses associated with the winter continental anticyclone.

Cloud amounts closely analogous to those at Fort Greely (4.6 to 6.5 tenths) occur in the Alps and the Scandinavian Peninsula in Europe, and in large areas of central and northeastern Siberia. Areas with cloud amounts closely analogous to that of Fort Churchill (3.8 to 5.7 tenths) are smaller and for the most part are in northeast Siberia and in a band extending over the Central Asiatic Block Mountains into central Siberia.

f. Mean Snow Depth, Month of Greatest Depth (Fig. 8)

Fort Greely: 17.0 inches, February
Fort Churchill: 25.1 inches, March

Snow depths plotted on Figure 8 are mean monthly depths for the month of maximum accumulation. The map presents only a generalized picture of the distribution of snow cover, since snow tends to be deposited in an extremely irregular manner. Snow depths are influenced greatly by local climatic conditions, topography, and vegetation. The distribution of snow depths in mountains is especially complicated, depending greatly on height, exposure, and nature of summits and slopes. In areas dominated by strong winds, exposed places are usually blown free of snow, which accumulates in appreciable amounts in depressions and forests. Where winds are not very strong, snow accumulates in a more or less even layer.

In Eurasia, snow depths are greatest on the western slopes of the Central Siberian Plateau and adjacent areas in the eastern part of the West Siberian Lowland in the vicinity of the Yenisey River. Depths decrease away from this central core, but secondary increases are noted on the western slopes of the Ural Mountains and in the far eastern areas of Kamchatka, Sakhalin, and the lower Amur.

Areas with snow depths closely analogous to that of Fort Churchill (20.0 to 30.0 inches) surround the central core area of deeper snow in a rather wide band, and extend over northern European Russia into Finland. Other analogous areas are located in Sakhalin Island, the lower Amur region, and a narrow strip extending from the Okhotsk Sea to the Bering Sea. Snow depths decrease both north and south from these areas and become analogous to those of Fort Greely (12.0 to 22.0 inches). Most of the northern coast, from the Kola Peninsula to the Yenisey River and from the Kolyma River to the Bering Straits, is analogous to Fort Greely, as is a fairly wide belt across middle Asia.

Snow storms occur most frequently in the tundra and steppe regions. They are particularly violent, often reaching blizzard proportions. In the European portion of the USSR, with the exception of the extreme north, the maximum number of snowstorms occurs in January. February and December have the next greatest number of storms.

E. Mean Temperature, Warmest Month (Fig. 9)

Fort Greely: 59°F, July
Fort Churchill: 54°F, July

There is a significant increase in the amount and intensity of solar radiation received over the continent in summer compared with winter. The surface of the earth, and the air in contact with it, are warmed considerably by long hours of sunlight, particularly in the northern areas. The heating of the huge land mass produces a weak thermal low pressure area which dominates most of the continent of Asia and produces weak north and northwest winds over European Russia.

The temperature distribution over the continent in summer is approximately latitudinal. This distribution varies only on the coasts bordering the Arctic Ocean, on the Scandinavian Peninsula, on Kamchatka Peninsula, on Sakhalin and Kurile Islands where maritime air from the Pacific exerts its influence, and in mountain areas where the varying topography is a controlling influence. Large inland bodies of water, such as Lake Baykal, also have a local effect on temperatures, producing cooler summer weather in their immediate vicinity.

The area having mean temperatures of the warmest month closely analogous to Fort Churchill's (49°F to 59°F) is very narrow, but stretches the entire breadth of the continent from the Atlantic to the Bering Sea. The southern limit of this area in Europe and the USSR follows approximately the 60th parallel of latitude except for a few, more southern extensions, that include practically all of Norway, most of Sweden, Kamchatka, and the coasts bordering the Okhotsk Sea. The area extends northward from this latitude to include all but a relatively narrow strip along the northern coasts where the cold arctic waters exert their influence. Another area of close analogy exists adjacent to and southwest of Lake Baykal, where higher elevations contribute to temperatures that are cooler than are characteristic of that latitude.

Temperatures analogous to those of Fort Greely (54°F to 64°F) lie within an area larger than the area closely analogous to Fort Churchill. A considerable overlap of areas analogous to both test sites occurs in the north. In Europe, the area closely analogous to Fort Greely extends from the Scandinavian Peninsula, almost all of which is analogous, into the Paris Basin. Much of northern European Russia is closely analogous, the area reaching across the northern part of the continent to eastern Siberia, where it again extends southward and includes much of the coast bordering on the Okhotsk Sea. Temperatures analogous to those at Fort Greely are also found near Lake Baykal, overlapping and surrounding the area delimited as closely analogous to Fort Churchill.

h. Mean Daily Maximum Temperature, Warmest Month (Fig. 10)

Fort Greely: 69°F., July
Fort Churchill: 64°F., July

In the USSR, daily maximum temperatures are not generally observed, and the 1300 LST observation is ordinarily considered the afternoon maximum. In summer, however, the 1300 LST observation can be several degrees lower than the maximum temperature. In winter, because of the relatively small diurnal variation, the difference between the 1300 LST observation and the mean daily maximum usually is smaller.

In order to arrive at a more representative value, an approximate mean daily maximum temperature was obtained, for stations lacking this value, by subtracting the mean daily minimum temperature (computed from observed values) from twice the mean temperature at each station for which both values are available. Some error exists in this method, since it assumes the mean to be an average of the means of the extremes, whereas the mean temperatures at these stations are actually an average of three daily observations. The error, however, is considered to be negligible for this type of analysis, and the method allows a more realistic comparison of mean daily maxima.

The areas closely analogous to each test site correspond generally to those of the mean temperature for the warmest month. The influence of the cold arctic seas is exhibited along the entire north coast where temperatures are too cool for close analogy with either test site. Summer heating in the continental interior limits the southern boundary of the area analogous to Fort Greely at about 60°N latitude in most of the USSR. In Europe, however, this southern limit is located at about 50°N latitude, owing to the influence of cooler maritime air from the Atlantic.

i. Absolute Maximum Temperature

Fort Greely: 90°F., May
Fort Churchill: 96°F., July

Since maximum temperatures in summer are not considered a critical factor in arctic and subarctic operations, no map was prepared for this element. Examination of data for the study area indicates that, in general, absolute temperatures between 85°F and 100°F can be expected in interior areas (Table VI).

The northern coasts from Norway to the Bering Sea, and the coasts bordering the Pacific Ocean, are influenced by their proximity to cold water and therefore do not experience the extreme temperatures typical of the interior. Maximum temperatures along the Arctic coast from the Kara Sea east to the Bering Strait range from 65°F to 75°F. Inland from the coasts, maximum temperatures increase rapidly. On Kamchatka Peninsula and along the coasts bordering the Okhotsk Sea, maximum temperatures range from 75°F to 85°F.

j. Mean Cloudiness, Warmest Month (Fig. 11)

Fort Greely: 6.4 tenths of sky covered, July
Fort Churchill: 6.4 tenths of sky covered, July

A large part of the study area is analogous in mean cloudiness to both sites. The Paris Basin and the Baltic Plain, central and northern parts of the Scandinavian Peninsula and Finland, and the northern part of the Central Russian Tableland are closely analogous. In Europe, summer cloudiness is caused by convective clouds which are not so persistent as the stratus and stratocumulus clouds of winter. Mean cloudiness in Europe, therefore, is less in summer than in winter. Siberia has a cloudiness maximum in summer. The Siberian summer maximum is also due to convective type clouds; winter skies are usually clear. Virtually all of Siberia is analogous except for the Arctic coast, Kamchatka Peninsula, and coasts bordering the Bering Sea. In those sections, cloudiness is greater than that of the test sites, but is within the semianalogous range. Mean cloudiness in the Kazakh Upland and the southern part of the West Siberian Lowland is less than at the test sites.

k. Mean Annual Precipitation (Fig. 12)

Fort Greely: 11.4 inches
Fort Churchill: 14.4 inches

In winter, northwest Europe is influenced by comparatively warm, moist maritime air coming from the southwest. Precipitation usually results from either frontal or orographic lifting. Low clouds and drizzle occur frequently. Precipitation amounts are evenly distributed throughout the year, and there is no pronounced dry season. In summer, precipitation is of the convectional, air mass type, although weak fronts infrequently contribute by releasing the convective instability over interior regions. Coastal regions exposed to the prevailing onshore circulation receive greater amounts of precipitation than the interior. Eastern Norway, Sweden, and Finland, sheltered by the Norwegian Mountains to the west, receive less precipitation than western Norway. Mean annual precipitation amounts closely analogous to those at Fort Churchill (11.4 to 17.4 inches) are received in northern interior Sweden, extreme northern Finland, and on the Kola Peninsula. Smaller areas, analogous to Fort Greely (8.4 to 14.4 inches) are found in northern Finland (near Karesuando and Karasjok), and on the east coast of the Kola Peninsula in the vicinity of Murmansk.

Central Europe is under the influence of both maritime air from the Atlantic and continental air from the interior of the vast Eurasian land mass. Precipitation decreases from west to east as the distance from the ocean increases. Summer is the season of maximum precipitation, which is predominantly of the shower type, produced mainly by continental heating of unstable air. Precipitation in all of central Europe is too great for analogy to either test site.

In most of the USSR the continental-type summer rainfall regime also predominates. A summer maximum of precipitation prevails as the result of convective showers or weak frontal activity. In winter, cold, dry air masses dominate the interior of the continent, and only small amounts of precipitation are received. Annual precipitation is greatest in European Russia and western Siberia, decreasing toward the northern coasts and the southern deserts. In western Siberia, the area analogous to Fort Greely is divided by a central core having greater precipitation. This area is semianalogous to Fort Greely, but, with the exception of the most central part, is closely analogous to Fort Churchill. The Arctic coast bordering the Kara Sea is drier than Fort Churchill but is semianalogous to Fort Greely.

All of the Central Siberian Plateau is analogous to Fort Greely. In the south, precipitation increases slightly in the Central Asiatic Block, and conditions become closely analogous to both test sites.

Northeastern Siberia is a region of little precipitation. Most of the stations within the region receive only 3 to 8 inches per year. On the east coast, low pressure systems produce more precipitation than is received in the interior, and as a result the coast from the Okhotsk Sea north to the Bering Strait is analogous to Fort Greely. Precipitation on Kamchatka Peninsula increases from north to south. A band across the center of the peninsula has precipitation closely analogous to that of Fort Churchill, and the northern portion receives amounts closely analogous to that of Fort Greely.

1. Atmospheric Humidity

At low temperatures the actual amount of water vapor in the atmosphere is extremely small, due to a much reduced moisture capacity of extremely cold air. As a consequence, the cold winter air masses of the Arctic and subarctic are extremely dry. Relative humidities, on the other hand, are usually high. In winter, relative humidities range between 75 and 100 percent throughout most of the study area. In summer, although relative humidities are slightly lower, the actual water vapor present in the atmosphere is greatly increased due to the capacity of the atmosphere to hold more water vapor at higher temperatures and due to the availability of moisture from the many lakes and swamps.

For all practical purposes, humidity and moisture conditions at the test sites may be considered comparable to those in areas of the arctic and subarctic regions wherever mean daily temperature analogy exists.

Mean relative humidities for selected stations are presented in tabular form in Table XII.

m. Fog (Fig. 12a)

In the Fort Greely area, as in most of the Yukon Valley, fogs are most frequent during the colder months, December through February. At this time of the year, radiation fogs form under a surface temperature inversion, and ice fogs form near cities and camps.

Radiation fogs are caused by a rapid fall in temperature when the air comes in contact with the ground or snow surface cooled through long-wave terrestrial radiation. Such fogs are common in the principal interior river valleys in Siberia and North America, and, as at Fort Greely, are usually shallow and of low density. At Fairbanks, Alaska, the months from December through February average between 4 and 5 days with light to dense fog.

During winter, burning of fuels in towns and camps supplies an abundance of condensation nuclei upon which sublimation of moisture in the form of ice crystals takes place. This results in the formation of ice fog. Langmuir and Schaefer (19) point out, however, that most sources of smoke are also sources of moisture, and that the fog might be due entirely to the additional moisture which accompanies the smoke. Horizontal visibilities during periods of ice fog may be reduced considerably in the fog layers, which vary from 50 to 500 feet in thickness. They occur in most interior areas subject to extremely low temperatures, and may occur even at coastal stations when under the influence of weather conditions favorable for fog formation. This type of fog is rare with temperatures above -20°F and with wind speeds in excess of 3 mph. V. J. Oliver and M. B. Oliver (27) have found that ice fog is not very likely to occur with temperatures between -20°F and -40°F but at temperatures colder than -40°F, ice fog will probably occur, and with temperatures colder than -50°F, ice fog is inevitable.

Ice fog frequencies at the test sites and in the study area reach their maximum during the cold months because of the requirement for extremely low temperatures for its formation. At Fort Churchill, ice fog occurs most frequently (108 hours) in February. Statistics available for Fort Greely for an 8-year period of record indicate that ice fog is most prevalent during December, January, and February, which have an average total of 115 hours of this type of fog.

Fort Churchill experiences its foggiest period from June through August; about 2 to 4 days during each month have dense fog. These fogs, which do not extend more than 20 miles inland, result from relatively warm moist air moving over the cold water of Hudson Bay. Over a large portion of the Siberian coast from the Kara Sea to Chuckchi Sea, similar fogs may be expected up to 90 or more days each year.

Figure 12a shows the mean number of days with fog at stations in the study area. Data plotted at each station indicate the mean annual number of days and the average occurrence in the coldest, warmest, and foggiest months. Areas with 10 or less and 60 or more days per year with fog are delimited by color. These areas should be regarded as only approximate, since the reported data are not based on standardized definitions of fog and differing methods of observing and reporting fog are used. For these reasons, and because fog in many cases is governed strongly by local influences, no attempt was made to delimit areas with fog conditions analogous to those of the test sites.

5. Analysis of Composite Maps

a. Composite Analogous Areas, Coldest Month (Fig. 13)

Temperature and windchill are two factors contributing to great environmental stress in the study area in the winter. In constructing this map, areas where analogous mean temperatures and mean daily minimum temperatures coincided were first outlined to indicate analogous coldest month temperature conditions. Areas with analogous mean minimum temperature in the coldest month are, in general, similar to those indicated for the mean temperature, coldest month, and therefore the composite of the two elements does not differ greatly from either one. Areas where analogous windchill conditions overlapped analogous temperature conditions were then delineated. Areas with analogous snow depth during the month of greatest depth were superimposed on the areas previously delimited, since depth of snow adds to climatic stress, especially in the use of certain items of equipment and in the movement of soldiers. Although in most cases the months of deepest snow and lowest temperature are not identical, it was felt, nevertheless, that the addition of snow depth data on this map provides essential information.

Areas where both temperature and windchill conditions are analogous to those of Fort Greely are extremely limited. These areas are confined principally to northern and eastern Novaya Zemlya and to the areas bordering the southern part of the Kara Sea in the vicinity of Amderma, Kara Guba, and Mare Sale; another small area is found in northeastern Chuckchi peninsula.

Windchill and temperature conditions analogous to those of Fort Churchill are found in the northern lowlands between the Ob and Yenisey Rivers, and in an area extending northeastward along the Arctic coast to the Lena River. A smaller area occurs in northeastern Siberia in the vicinity of Mys Billingsa.

b. Composite Analogous Areas, Fort Greely (Fig. 14)

This and the following composite map (Fig. 15) each synthesize for a single test site, analogous areas of annual temperature and precipitation, the parameters regarded as most important in determining total environmental analogy. Areas of winter temperature analogy are those previously delimited in Figure 13. The procedure outlined for obtaining these areas was also used in determining summer temperature analogy; that is, areas of analogous mean temperatures for the warmest month were combined with areas of analogous mean maximum temperature for the warmest month, and coincident areas delimited. Areas which did not show analogy on both mean and mean extreme maps for the season were excluded from the composite map. Areas of summer temperature analogy are indicated in yellow and those of winter temperature analogy in blue. The overlap of the warmest and coldest month areas is a composite area where temperature conditions are analogous in both of the extreme seasons. Areas where mean annual precipitation is analogous to that of Fort Greely were then superimposed and delimited where they overlapped areas of temperature analogy.

Three areas of analogous winter-summer temperature conditions are depicted. The first is located in the northeastern Central Russian Tableland and the northwestern sector of the West Siberian Lowland, extending southeast from the northern limit of forests to about 60° N. latitude. Another area of analogous temperatures is located in northern and central Kamchatka Peninsula and in the area around the Gulf of Shelikhova. The third area extends over northern Sakhalin Island and a small area east of the Amur River.

When areas of analogous precipitation are superimposed, only the northeastern part of the central Russian Tableland- West Siberian Lowland region and the northwestern portion of the Kamchatka Peninsula remain analogous.

Larger analogous areas occur when annual precipitation is considered with either summer or winter temperature. Summer temperatures and annual precipitation in the northern portion of the West Siberian Lowland and the Central Siberian Plateau are analogous to those of Fort Greely, and smaller areas appear between the East Siberian Highlands and the Koryak Mountains, and in the extreme eastern part of the Aldan Plateau. Winter temperature and annual precipitation analogy is found in the southern part of the West Siberian Lowland, over the western Central Asiatic Block Mountains, in the Lake Baykal region, on the Chuckchi Peninsula, and in a coastal strip bordering the Bering Sea.

c. Composite Analogous Areas, Fort Churchill (Fig. 15)

This map was prepared to show areas of composite analogy to Fort Churchill, for the same elements as were used in the preceding map of composite Fort Greely analogy.

Combined winter-summer temperature analogy to Fort Churchill exists in the northern West Siberian Lowland and in the Arctic Lowlands to the north. Central Siberia is too cold for analogy in winter, although a summer temperature analogy occurs in the northern portion. Additional areas of winter-summer temperature analogy are located in the lower elevations of the east slopes of the East Siberian Highlands and the Verkhoyansk Ranges.

The principal areas of summer temperature and annual precipitation analogy are located in northern European Russia, extending across the Kola Peninsula into the Swedish Uplands and on Kamchatka Peninsula. Winter temperatures and annual precipitation are analogous in a discontinuous strip along the Nizhnyaya Tunguska River through the Central Siberian Plateau and extend into the Mongolian Plateau in the East.

Composite winter-summer temperature and annual precipitation analogy is confined to two rather small areas in the West Siberian Lowland and a third in the extreme eastern part of the Aldan Plateau. Thus the principal area of triple analogy for Fort Churchill lies east of the Ob, while for Fort Greely the principal area lies west of the Ob.

6. Tables of Monthly Climatic Averages for Selected Stations

Tables I through XIII list the monthly values of climatic elements for 27 stations in Eurasia. These stations were selected as representative of climatic conditions of various parts of the study area. Station names are listed in Table I, with geographic coordinates and elevation above mean sea level. No stations are included for the Central Siberian Plateau, due to scarcity and unreliability of available data. In each table, mean values for Fort Greely and Fort Churchill are also shown for comparison. The elements for which tables are prepared are those used in the map series, and tables of absolute maximum temperature, relative humidity, and frequency of fog have been added. Regions represented by the stations can be determined from the map of Major Physical Features (Fig. 2).

These tables supplement the seasonal maps by giving a picture of the climatic regime throughout the year.

TABLE I: LOCATION AND ELEVATION OF STATIONS

Station	Elevation (Feet)	Latitude (°)	Latitude (')		Longitude (°)	Longitude (')	
Arkhangelsk, USSR	20	64	28	N	40	31	E
Barnual, USSR	535	53	20	N	83	47	E
Berezovo, USSR	138	63	56	N	65	04	E
Borno, Norway	16	65	28	N	12	12	E
Borzya, USSR	2243	50	24	N	116	29	E
Budapest, Hungary	426	47	31	N	19	01	E
Dikson O., USSR	66	73	30	N	80	23	E
FORT CHURCHILL, CANADA	115	58	47	N	94	17	W
FORT GREELY, ALASKA	1274	64	00	N	145	44	W
Gizhiga, USSR	33	62	02	N	160	40	E
Helsinki, Finland	39	60	10	N	24	57	E
Igarka, USSR	115	67	32	N	86	50	E
Irkutsk, USSR	1532	52	16	N	104	19	E
Matochkin Shar, USSR	61	73	16	N	56	24	E
Moskva, USSR	528	55	47	N	37	38	E
Mys Chelyuskin, USSR	20	77	43	N	104	17	E
Nikolaevsk, USSR	108	53	08	N	140	45	E
Okhotsk, USSR	20	59	21	N	143	17	E
Paris, France	164	48	48	N	2	30	E
Petropavlovsk, USSR	286	52	53	N	158	43	E
Rostov, USSR	157	47	13	N	39	[illegible]	E
Samarovo, USSR	314	60	58	N	69	04	E
Sredne Kolymsk, USSR	98	67	10	N	157	10	E
Tiksi, USSR	23	71	35	N	128	55	E
Uralsk, USSR	124	51	12	N	51	22	E
Verkhoyansk, USSR	400	67	33	N	133	24	E
Vilyusk, USSR	394	63	45	N	121	35	E
Vrangelya O., USSR	10	70	58	N	181	27	E
Warszawa, Poland	361	52	12	N	21	00	E

Table II: MEAN TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	35	8	10	17	30	41	53	60	55	46	34	21	12	32
Barnual	33	-1	2	15	34	52	64	68	63	52	36	17	5	34
Berezevo	M	-9	-2	9	24	37	52	61	56	44	27	8	-3	25
Borno	60	32	31	32	38	44	50	55	54	50	42	36	32	41
Borzya	15	-19	-11	6	32	48	62	67	62	50	30	5	-12	27
Budapest	30	31	34	43	52	62	68	71	69	61	52	41	35	52
Dikson O.	M	-14	-12	-11	0	17	32	40	41	35	20	1	-10	12
FORT CHURCHILL	19	-19	-17	-6	14	30	43	54	52	42	27	6	-11	18
FORT GREELY	9	-5	2	12	28	46	56	59	54	44	27	5	-4	27
Gizhiga	16	-11	-9	1	15	33	49	56	52	41	22	3	-8	23
Helsinki	92	21	20	25	34	46	57	62	60	51	42	32	25	40
Igarka	7	-20	-13	-4	10	27	46	59	55	41	19	-5	-17	17
Irkutsk	35	-6	-1	14	33	46	58	62	59	46	32	13	-1	30
Matochkin Shar	17	6	2	-3	10	24	34	42	43	36	27	19	9	43
Moskva	35	13	16	23	38	53	60	64	60	50	39	27	18	38
Mys Chelyuskin	11	-14	-13	-19	-5	15	30	35	32	27	13	-6	-15	7
Nikolaevsk	63	-10	-4	9	27	39	53	62	61	49	29	15	-3	28
Okhotsk	32	-10	-7	6	21	35	44	54	55	46	27	5	-7	22
Paris	20	38	39	44	50	56	62	66	65	60	52	43	40	51
Petropavlovsk	16	14	15	22	30	36	44	51	54	49	40	27	19	33
Rostov	30	21	25	34	48	62	69	75	73	62	50	36	28	49
Samarovo	M	-4	1	14	31	44	60	66	60	48	31	12	0	30
Sredne Kolymsk	13	-40	-33	-17	5	30	55	57	50	37	12	-18	-34	9
Tiksi	7	M	-20	M	M	M	M	48	M	M	M	M	M	M
Uralsk	20	4	10	18	39	59	68	74	69	56	42	23	11	39
Verkhoyansk	38	-58	-48	-24	9	36	56	60	52	36	6	-34	-51	3
Vilyusk	25	-38	-24	-4	18	40	59	65	58	42	17	-15	-35	15
Vrangelya O.	9	-11	-14	-10	1	17	33	37	36	28	16	1	-5	11
Warszawa	25	26	28	35	46	57	63	65	64	57	47	36	29	46

M - Missing
Values for coldest and warmest month are underlined

M - Missing
Values for coldest and warmest month are underlined

Table III: MEAN DAILY MINIMUM TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr.	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	18	1	0	8	23	35	44	51	48	40	30	16	4	25
Barnual	18	-12	-9	2	23	40	51	55	52	41	28	10	-4	23
Berezevo	M	-13	-11	-2	15	29	45	53	48	38	21	0	-12	17
Borno	20	27	28	29	34	40	45	51	51	45	37	32	28	37
Borzya	9	-32	-24	-7	17	34	48	56	52	35	17	-8	-25	13
Budapest	30	28	28	36	43	51	56	60	58	52	44	36	31	44
Dikson O.	M	-20	-19	-18	-8	12	29	36	37	32	16	-6	-17	6
FORT CHURCHILL	19	-27	-25	-16	4	22	34	43	43	34	20	-2	-19	9
FORT GREELY	9	-13	-7	1	18	36	46	49	44	36	20	-2	-13	18
Gizhiga	5	-19	-14	-7	6	25	38	44	43	32	15	-7	-18	12
Helsinki	20	17	15	22	31	41	49	57	54	47	36	30	22	35
Igarka	7	-30	-22	-16	-2	19	38	50	47	35	14	-13	-27	7
Irkutsk	18	-17	-14	-1	21	33	44	50	48	35	22	2	-11	18
Matochkin Shar	16	-4	-4	-11	1	17	30	37	37	32	22	9	-2	14
Moskva	25	6	8	16	30	42	50	54	51	42	33	22	12	33
Mys Chelyuskin	7	-7	-21	-26	-14	9	27	32	31	26	8	-9	-19	2
Nikolaevsk	22	-4	-15	-2	18	32	45	54	53	44	29	8	-10	20
Okhotsk	7	-15	-17	-7	8	26	37	48	47	38	21	0	-12	14
Paris	20	32	33	36	40	46	52	55	54	50	44	37	35	43
Petropavlovsk	12	9	10	15	25	32	39	47	48	43	34	22	14	28
Rostov	30	13	19	28	40	52	60	64	61	52	41	31	23	40
Samarovo	9	-14	-7	0	19	47	47	56	51	41	24	5	-10	22
Sredne Kolymsk	9	-49	-40	-29	-11	18	43	48	41	30	5	-23	-40	-1
Tiksi	7	-24	-26	-28	-9	14	32	41	41	32	7	-17	-26	3
Uralsk	17	-4	1	11	30	46	55	59	55	45	33	17	3	29
Verkhoyansk	14	-66	-56	-39	-12	22	43	47	39	27	-4	-40	-58	-8
Vilyusk	11	-45	-32	-18	2	28	46	52	46	34	10	-22	-43	5
Vrangelya O.	10	-18	-21	-18	-6	11	28	32	32	25	12	-5	-12	5
Warszawa	25	21	23	28	38	48	53	56	55	48	41	32	25	39

Values for coldest month are underlined
M - Missing

Table IV: MEAN DAILY MAXIMUM TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	18 - 35	15	20	26	37	46	62	68	62	52	38	26	20	39
Barnual	18 - 33	10	13	28	45	64	77	81	74	63	45	24	2	45
Berezevo	M	-1	7	20	33	45	60	70	64	51	33	15	6	34
Borno	20	32	33	36	42	48	53	60	59	52	44	37	33	44
Borzya	9 - 15	-6	2	5	47	62	76	79	72	65	43	18	1	41
Budapest	30	37	40	52	62	72	77	82	81	73	62	48	39	60
Dikson O.	14	-4	-3	-5	6	22	35	46	46	39	24	9	-1	18
FORT CHURCHILL	19	-11	-8	4	24	38	52	64	62	49	34	13	-3	26
FORT GREELY	9	3	11	23	38	56	66	69	63	52	34	13	4	36
Gizhiga	5	-3	-4	9	24	41	60	68	61	50	29	13	2	29
Helsinki	20	26	26	32	43	55	63	71	65	57	45	37	31	46
Igarka	7	-10	-4	8	22	25	54	68	63	47	24	3	-7	24
Irkutsk	18 - 35	5	12	29	45	59	72	76	70	58	42	24	9	42
Matochkin Shar	17	12	8	4	15	28	25	48	48	39	31	24	15	26
Moskva	25 - 35	20	24	30	46	64	70	74	69	58	45	32	24	43
Mys Chelyuskin	7 - 11	-5	-5	-12	4	21	33	38	33	28	18	-3	-11	12
Nikolaevsk	22 - 63	-1	7	20	36	46	61	70	69	54	29	22	4	36
Okhotsk	7 - 32	-5	3	5	34	44	51	60	63	54	33	10	-2	30
Paris	20	44	46	52	60	67	72	76	75	69	60	49	44	59
Petropavlovsk	12 - 16	19	20	29	35	33	49	55	60	55	46	32	24	38
Rostov	M	27	31	40	56	72	78	86	85	72	59	41	33	58
Samarovo	M	6	9	14	43	41	73	76	69	55	38	19	10	38
Sredne Kolymsk	9	-31	-26	-5	21	42	67	66	59	44	19	-13	-28	19
Tiksi	7	M	-14	M	M	M	M	55	M	M	M	M	M	M
Uralsk	17	12	19	25	48	72	81	89	83	68	51	29	19	49
Verkhoyansk	14	-50	-40	-9	30	50	69	73	65	45	16	-28	-44	14
Vilyusk	11	-31	-16	10	34	57	72	78	70	50	24	-8	-27	25
Vrangelya O.	10	-4	-7	-2	8	23	38	42	40	31	20	7	2	17
Warszawa	25	31	33	42	54	66	73	74	73	66	53	40	33	53

Values for warmest month are underlined
M - Missing

Table V: ABSOLUTE MINIMUM TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arkhangelsk	35	-49	-41	-35	-18	8	26	34	33	20	-5	-22	-45
Barnual	33	-55	-55	-42	-19	4	29	37	32	21	-30	-49	-51
Berezevo	M	-57	-52	-49	-20	-2	25	32	22	11	-13	-41	-53
Borno	55	3	2	8	14	25	33	38	36	30	19	12	0
Borsya	9	-55	-56	-37	-16	11	25	36	34	12	-19	-40	-61
Budapest	30	2	-10	8	24	33	37	48	45	34	15	11	-2
Dikson O.	15	-52	-55	-46	-35	-14	7	27	26	11	-15	-39	-49
FORT CHURCHILL	19	-57	-52	-52	-26	-14	13	22	25	15	-17	-53	-47
FORT GREELY	9	-65	-60	-39	-37	-1	32	35	22	9	-15	-42	-62
Gizhiga	12	-59	-52	-52	-23	-3	28	35	25	8	-21	-39	-50
Helsinki	44	-23	-21	-16	12	25	34	42	32	28	14	-5	-18
Igarka	7	-70	-71	-63	-47	-16	15	33	31	15	-21	-61	-76
Irkutsk	30	-58	-48	-34	-24	6	24	33	27	14	-23	-39	-51
Matochkin Shar	16	-38	-39	-41	-28	-10	13	25	27	7	-12	-23	-41
Moskva	37	-43	-40	-26	1	19	28	38	33	23	-1	-9	-40
Mys Chelyuskin	6	-54	-48	-42	-37	-15	11	26	24	2	-16	-41	-46
Nikolaevsk	22	-50	-51	-34	-13	12	25	38	36	1	1	-29	-40
Okhotsk	19	-40	-50	-34	-30	3	27	36	34	16	-6	-26	-33
Paris	172	-2	4	10	24	29	36	40	41	33	22	5	-14
Petropavlovsk	23	-29	-25	-12	4	14	29	35	35	30	18	5	-15
Rostov	24	-19	-15	-6	18	30	36	47	40	25	14	1	-11
Samarovo	9	-49	-41	-39	-14	5	29	34	30	20	-21	-42	-52
Sredne Kolymsk	9	-71	-72	-61	-42	-16	22	33	24	9	-30	-53	-72
Tiksi	7	-54	-57	-47	-30	-14	18	29	27	18	-27	-49	-50
Uralsk	25	-42	-30	-24	-10	23	32	41	32	20	6	-31	-39
Verkhoyansk	33	-90	-94*	-77	-66	-30	19	28	18	2	-48	-72	-84
Vilyusk	11	-76	-68	-58	-34	-9	28	32	21	-3	-32	-60	-72
Vrangelya O.	10	-43	-43	-50	-27	-13	14	23	24	6	-10	-28	-34
Warszawa	44	-22	-28	-14	22	30	35	43	41	29	15	0	-5

Absolute values for period of record are underlined
M - Missing
*Also reported as corrected to -90°

Table VI: HIGHEST REPORTED TEMPERATURE (°F)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arkhangelsk	95	41	39	54	67	83	90	94	89	77	65	50	39
Barnual	37	40	40	52	79	90	94	96	95	87	75	54	40
Berezevo	10	30	32	46	58	77	84	86	84	76	64	39	36
Borno	55	48	50	55	70	76	84	87	81	74	66	55	51
Borzya	11	20	28	50	74	87	99	99	94	81	73	40	31
Budapest	30	59	64	78	87	90	103	101	101	95	80	73	56
Dikson O.	M	31	30	27	33	45	67	73	69	55	40	32	31
FORT CHURCHILL	19	39	31	41	62	87	83	96	87	84	62	45	34
FORT GREELY	9	46	51	51	62	90	86	85	82	73	62	50	48
Gizhiga	12	34	35	38	40	65	77	82	80	67	53	38	32
Helsinki	39	47	43	53	67	77	84	83	84	74	59	49	46
Igarka	7	28	27	32	49	61	89	83	82	68	50	33	32
Irkutsk	30	36	41	52	85	88	95	98	92	84	73	56	36
Matochkin Shar	17	41	42	37	41	55	56	66	68	54	53	42	43
Moskva	105	43	43	64	78	95	93	97	100	89	72	57	46
Mys Chelyuskin	7	28	24	27	26	36	48	67	63	56	34	33	29
Nikolaevsk	22	M	M	M	M	M	M	88	M	M	M	M	M
Okhotsk	32	27	30	37	43	59	73	77	78	74	57	36	32
Paris	172	60	69	79	85	92	96	101	99	96	83	71	64
Petropavlovsk	26	40	44	44	53	65	74	84	81	73	64	45	43
Rostov	30	55	54	55	80	82	89	99	102	100	95	89	69
Samarovo	9	32	33	44	61	82	88	92	87	81	63	38	35
Sredne Kolymsk	13	8	17	30	42	74	94	92	85	67	51	24	9
Tiksi	7	25	13	22	36	74	75	91	81	68	45	25	18
Uralsk	25	36	35	60	79	92	101	104	98	96	81	56	39
Verkhoyansk	33	2	14	38	52	71	94	93	88	7[illegible]	48	33	32
Vilyusk	25	21	30	41	60	78	93	96	93	78	64	34	22
Vrangelya O.	9	33	27	28	33	49	63	65	61	46	38	35	29
Warszawa	44	51	54	69	78	93	96	96	98	88	77	60	57

Absolute values for period of record are underlined
M - Missing

Warszawa [illegible]

Absolute values for period of record are underlined
M - Missing

Table VII: MEAN WIND SPEED (Miles per hour)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	10	11.9	9.5	10.6	9.0	10.2	10.4	8.7	9.5	10.7	11.3	12.4	9.7	10.3
Barnual	13	7.0	7.0	6.0	7.0	8.0	7.0	6.0	5.0	6.0	8.0	8.0	6.0	7.0
Berezeve	M	7.2	7.6	8.5	8.5	9.2	9.6	8.3	8.5	7.8	8.7	8.3	7.6	8.3
Borno	26	15.7	14.9	14.9	12.7	13.4	14.2	12.7	11.9	13.4	13.4	14.2	14.2	13.8
Borzya	11	3.9	4.5	6.6	9.8	10.0	8.7	7.5	7.3	7.3	7.6	6.2	4.2	7.0
Budapest	30	4.1	3.9	4.1	4.4	4.1	4.4	4.6	4.2	3.6	3.0	3.4	3.2	3.9
Dikson O.	M	19.0	19.0	17.0	15.9	15.4	14.7	14.5	15.0	15.7	17.4	16.3	18.1	16.5
FORT CHURCHILL	19	14.9	14.6	14.2	14.3	13.4	12.2	11.5	13.0	16.3	17.1	16.9	14.9	14.4
FORT GREELY	9	17.0	17.0	10.0	9.0	10.0	9.0	3.0	10.0	10.0	13.0	15.0	14.0	11.8
Gizhiga	M	12.0	11.0	11.0	10.0	9.0	9.0	9.0	8.0	7.0	9.0	10.0	12.0	10.0
Helsinki	16	10.2	9.1	9.4	8.1	8.4	8.3	7.6	7.9	9.1	9.9	9.9	10.1	9.0
Igarka	7	8.0	9.0	10.0	10.0	11.0	10.0	8.0	9.0	10.0	10.0	9.0	7.0	9.0
Irkutsk	10	6.4	6.5	6.8	9.3	9.0	14.4	6.1	5.7	6.3	7.2	6.7	6.2	7.6
Matochkin Shar	17	17.0	15.0	18.0	16.0	16.0	17.0	15.0	12.0	14.0	15.0	17.0	14.0	16.0
Moskva	10	8.4	8.1	8.3	7.5	7.5	7.0	6.9	7.2	8.0	7.8	9.0	8.4	7.8
Mys Chelyuskin	M	19.0	12.0	13.0	12.0	12.0	14.0	15.0	12.0	14.0	14.0	10.0	11.0	12.0
Nikolaevsk	16	8.1	6.4	7.4	7.1	7.8	8.9	8.1	6.8	6.9	7.5	8.4	8.8	7.7
Okhotsk	13	9.8	9.2	8.1	8.7	8.9	9.2	8.9	8.3	8.7	11.0	11.9	10.7	9.4
Paris	Not available													
Petropavlovsk	16	19.8	18.0	19.0	14.3	11.3	9.6	9.4	8.1	11.4	14.4	16.6	18.1	14.2
Rostov	11	14.0	12.0	11.0	12.0	10.0	9.0	9.0	9.0	9.0	10.0	11.0	11.0	11.0
Samarovo	M	8.5	8.0	8.7	8.5	9.2	8.3	7.4	7.4	8.7	8.5	8.5	8.3	8.3
Sredne Kolymsk	M	3.6	3.1	4.3	4.9	4.5	6.5	6.5	6.0	5.8	4.3	3.6	3.8	4.7
Tikei	M	17.0	12.5	6.7	6.0	9.6	9.2	8.9	10.5	11.6	11.2	10.1	8.1	10.1
Uralsk	6	14.0	12.0	15.0	15.0	15.0	13.0	12.0	12.0	14.0	14.0	14.0	15.0	13.8
Verkhoyansk	16	1.4	1.6	2.2	4.0	5.7	6.8	5.6	4.6	3.5	2.7	1.8	1.2	3.4
Vilyusk	11	4.2	4.1	5.2	6.3	6.6	6.2	5.3	5.4	5.2	5.6	4.8	3.9	5.2
Vrangelya O.	9	15.0	13.2	9.2	10.3	9.2	7.6	9.6	10.1	13.4	13.9	15.0	13.6	11.7
Warsawa	Not available													

Values for coldest month are underlined
M - Missing

Table VIII: MEAN WINDCHILL* (Kg. Cal./m^2/hr.)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	1200	1225	1144	903	759	578	462	548	698	882	1103	1195	900
Barnual	1220	1215	1022	796	563	380	313	366	527	792	1063	1156	784
Berezevo	1390	1335	1211	991	800	593	434	520	677	947	1226	1349	956
Borno	990	924	977	852	756	671	581	586	660	788	898	963	810
Borzya	1348	1319	1184	894	653	452	349	408	574	877	1156	1263	873
Budapest	700	695	591	481	359	285	263	274	371	453	579	648	475
Dikson O.	1790	1785	1729	1524	1224	977	846	829	940	1205	1507	1732	1341
FORT CHURCHILL	1820	1790	1595	1270	985	760	575	625	825	1090	1450	1695	1207
FORT GREELY	1630	1520	1200	930	680	515	455	560	710	1030	1430	1555	1018
Oizhiga	1590	1543	1389	1150	858	623	520	363	699	1020	1330	1558	1070
Helsinki	1040	1030	976	820	649	492	420	449	594	743	894	999	759
Igarka	1592	1535	1436	1225	990	683	476	535	759	1090	1417	1504	1104
Irkutsk	1310	1282	1074	858	667	541	380	434	607	824	1087	1236	824
Matochkin Shar	1442	1471	1610	1357	1124	969	813	758	898	1059	1222	1336	1172
Moskva	1120	1077	677	763	549	436	380	436	592	749	947	1049	731
Mys Chelyuskin	1770	1696	1770	1511	1197	995	928	931	1044	1271	1466	1635	1346
Nikolaevsk	1450	1276	1143	893	749	564	420	422	588	892	1092	1388	906
Okhotsk	1530	1446	1220	1035	829	697	550	520	667	990	1354	1512	1029
Paris			Wind Speed	data not	available								
Petropavlovsk	1360	1305	1198	995	851	713	594	533	652	883	1087	1237	946
Rostov	1150	1040	392	680	442	329	241	270	432	623	851	974	660
Samarove	1390	1292	1138	888	697	449	352	436	638	888	1167	1306	886
Sredne Kolymsk	1625	1429	1324	1113	791	505	477	554	728	969	1336	1531	1032
Tiksi	M	1780	M	M	M	M	638	M	M	M	M	M	M
Uralsk	1370	1276	1207	862	533	373	273	351	574	801	1109	1174	825
Verkhoyansk	1400	1471	1217	1006	741	491	436	507	676	981	1323	1320	964
Vilyusk	1600	1409	1230	982	613	434	340	430	636	1032	1370	1543	968
Vrangelya O.	1675	1670	1491	1361	1094	835	819	834	1011	1222	1487	1563	1255
Warszawa			Wind Speed	data not	available								

Values for coldest month are underlined
*Computed from values in Tables II & VII
M = Missing

TABLE IX: MEAN CLOUDINESS (in tenths of sky covered)

TABLE IX: MEAN CLOUDINESS (in tenths of sky covered)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	20	8.1	7.9	7.0	7.0	7.3	6.7	7.1	7.7	8.1	8.3	8.6	8.4	7.7
Barnaul	11	5.7	5.7	5.1	5.1	5.8	5.8	5.3	5.6	5.9	6.7	7.4	6.8	6.0
Berezevo		Not available												
Berno	14	7.2	7.1	6.8	6.5	6.6	6.8	7.0	7.0	7.5	7.1	7.1	6.8	7.0
Borzya	11	2.3	1.9	2.6	4.4	5.0	5.5	5.7	5.6	4.3	4.2	3.1	2.9	4.0
Budapest	50	6.7	6.1	5.5	5.4	5.0	4.8	4.1	3.8	4.0	5.5	6.6	7.1	5.4
Dikson O.	M	6.2	6.6	6.0	6.9	8.2	8.7	7.7	8.6	8.8	8.5	7.6	6.1	7.5
FORT CHURCHILL	8 - 10	4.7	4.5	4.8	5.9	7.7	7.2	6.4	6.8	8.0	8.3	7.5	5.4	6.4
FORT GREELY	9	5.5	5.5	6.1	5.6	6.2	5.8	6.4	7.0	6.8	6.6	5.8	5.5	6.1
Gizhiga	14	5.5	5.3	5.3	6.4	6.8	7.3	7.6	7.2	6.7	7.0	6.4	5.6	6.4
Helsinki	36	8.0	7.5	6.7	6.4	5.9	5.5	5.3	6.2	6.3	7.4	8.1	8.3	6.8
Igarka	M	5.8	5.8	6.8	5.8	6.7	7.5	6.4	7.4	8.0	8.5	7.6	7.1	6.9
Irkutsk	20	5.2	4.6	5.0	5.8	6.5	6.6	6.8	6.3	6.0	6.1	6.5	6.7	6.0
Matochkin Shar	17	6.9	6.9	6.5	6.8	8.0	7.5	7.0	7.8	8.2	8.3	8.0	7.2	[illegible]
Moskva	10	7.4	7.4	7.5	5.9	5.3	5.6	5.3	5.6	6.9	7.4	8.7	8.5	6.8
Mys Chelyuskin	M	5.9	6.6	4.2	7.0	9.2	8.7	9.0	8.9	8.4	8.0	5.8	3.6	7.1
Nikolaevsk	18	4.3	4.5	5.2	6.3	7.3	6.8	7.3	6.9	5.9	6.3	5.5	5.2	6.0
Okhotsk	15	3.7	3.7	4.5	5.7	7.3	7.7	7.8	7.2	5.5	4.8	4.2	3.8	5.5
Paris	10	7.5	6.5	6.0	6.4	6.1	5.7	5.8	5.6	5.6	6.4	7.3	7.4	6.4
Petropavlovsk	16	5.7	5.6	6.0	6.6	7.0	7.9	7.4	7.1	6.0	5.5	5.6	5.7	6.3
Rostov	10	7.7	7.9	7.8	6.4	4.7	5.1	3.6	2.9	3.5	5.0	7.7	8.4	5.9
Sararovo	M	6.0	5.1	5.6	6.0	6.6	6.4	6.6	6.7	7.0	7.4	6.7	6.3	6.4
Sredne Kolymsk	9	4.0	4.2	3.2	3.4	5.1	5.7	6.2	7.2	7.0	6.8	5.4	4.8	5.3
Tiksi		Not available												
Uralsk	7	6.7	5.7	6.5	5.1	4.6	5.0	4.4	4.3	5.0	6.4	7.1	7.2	5.6
Verkhoyansk	33	3.4	3.1	3.3	4.8	6.1	6.4	6.4	6.6	6.6	6.4	4.6	3.9	5.1
Vilyuisk	25	6.6	6.3	5.6	6.5	7.2	7.1	6.7	6.9	7.5	7.9	7.0	6.3	6.8
Vrangelya O.	9	5.5	5.8	5.0	5.4	7.9	7.4	7.2	7.9	8.1	7.4	6.7	6.4	6.7
Warsawa	M	7.6	7.4	6.8	6.5	5.9	5.9	6.1	5.8	5.8	6.7	8.0	9.2	6.7

Values for coldest and warmest months are underlined
M - missing

Table X: Mean Snow Depth (inches)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arkhangelsk	25	17.3	23.6	25.9	11.5	0.6	0.0	0.0	0.0	0.0	0.9	4.4	10.6
Barnual	18	9.2	11.4	7.2	2.4	0.0	0.0	0.0	0.0	0.0	0.5	2.7	6.3
Berezevo	M	17.4	20.6	22.4	17.2	3.0	0.0	0.0	0.0	0.0	1.3	7.2	13.6
Borno		Not available											
Borzya	2	1.9	2.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9
Budapest		Not available											
Dikson O.	M	11.0	9.8	10.6	11.8	10.2	4.0	0.0	0.0	0.3	5.7	7.9	10.2
FORT CHURCHILL	7- 10	16.0	20.9	25.1	20.4	10.6	4.0	T	0.0	0.0	0.7	4.4	10.2
FORT GREELY	5	10.7	17.0	14.9	11.6	9.6	2.0	0.0	0.0	T	4.2	7.0	10.5
Gizhiga	M	13.8	19.7	24.6	27.0	12.6	0.0	0.0	0.0	0.0	0.6	3.2	8.0
Helsinki	20	9.0	15.0	18.0	6.0	0.4	0.0	0.0	0.0	0.0	0.3	1.0	5.0
Igarka		Not available											
Irkutsk	18	6.7	8.4	7.2	0.4	0.2	0.0	0.0	0.0	0.0	0.5	2.5	4.7
Matochkin Shar		Not available											
Moskva	54	8.2	12.0	12.1	2.8	0.0	0.0	0.0	0.0	0.0	0.2	1.2	4.4
Mys Chelyuskin	8	7.5	7.5	8.1	8.3	8.1	4.8	0.4	0.0	0.8	3.2	5.1	7.1
Nikolaevsk	16	21.1	26.1	26.3	20.5	3.6	0.0	0.0	0.0	0.0	0.6	5.8	16.0
Okhotsk		Not available											
Paris	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Petropavlovsk	33	26.7	39.1	41.9	21.7	0.0	0.0	0.0	0.0	0.0	0.0	3.4	8.4
Rostov	19	3.3	3.3	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.3
Samarovo	M	15.3	19.0	21.4	15.0	0.3	0.0	0.0	0.0	0.3	1.2	7.1	12.2
Sredne Kolymsk	9	15.0	17.4	13.5	16.4	8.0	0.0	0.0	0.0	0.0	3.9	8.9	11.9
Tiksi		Not available											
Uralsk		Not available											
Verkhoyansk	16	8.0	9.5	10.6	10.1	3.4	0.0	0.0	0.0	0.0	2.9	5.9	7.5
Vilyusk	14	13.9	15.5	16.6	14.7	4.1	0.0	0.0	0.0	0.1	2.0	7.1	11.0
Vrangelya O.		Not available											
Warszawa		Not available											

Values for month of greatest depth are underlined
M = Missing

Table XI: MEAN PRECIPITATION (inches)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	45	0.89	0.78	0.90	0.78	1.43	2.01	2.37	2.53	2.24	1.78	1.27	1.05	18.33
Barnual	75	0.75	0.51	0.55	0.59	1.26	1.73	2.13	1.77	1.14	1.26	1.06	1.02	13.77
Berezevo	8	0.50	0.30	0.40	0.60	1.50	2.20	2.50	2.00	1.50	0.90	0.60	0.50	13.50
Borno	50	3.54	2.99	2.48	2.17	2.48	2.48	2.95	3.27	5.12	4.65	4.68	3.23	40.04
Borzya	15	0.08	0.04	0.04	0.16	0.67	1.10	3.07	2.99	0.98	0.12	0.08	0.08	9.49
Budapest	35	1.46	1.22	1.77	2.28	2.91	2.91	2.09	1.97	2.01	2.60	2.09	1.87	25.20
Dikson O.	11	0.29	0.18	0.15	0.29	0.26	0.66	0.95	1.46	1.14	0.46	0.40	0.24	6.48
FORT CHURCHILL	19	0.41	0.36	0.63	0.69	0.65	1.51	2.81	2.54	1.97	1.50	0.76	0.56	14.40
FORT GREELY	9	0.40	0.20	0.30	0.30	0.60	2.10	3.20	2.10	1.20	0.40	0.30	0.30	11.40
Gizhiga	16	0.30	0.30	0.40	0.30	0.40	0.70	1.70	1.80	1.20	1.00	0.60	0.40	9.20
Helsinki	71	1.77	1.46	1.38	1.42	1.77	1.81	2.24	2.91	2.52	2.60	2.43	2.01	24.37
Igarka	7	0.95	0.67	0.75	0.67	0.95	2.00	1.97	1.97	2.05	1.38	1.22	1.02	15.60
Irkutsk	35	0.39	0.28	0.28	0.24	1.50	2.17	3.46	3.11	1.69	0.75	0.67	0.63	15.37
Matochkin Shar	16	0.40	0.30	0.20	0.30	0.30	0.60	1.30	1.30	1.50	0.60	0.60	0.40	7.60
Moskva	18	1.57	1.44	1.43	1.44	1.91	2.48	3.12	2.76	2.36	2.52	1.78	1.65	24.46
Mys Chelyuskin	7	0.20	0.10	0.00	0.10	0.10	0.50	1.00	0.90	0.30	0.30	0.20	0.10	3.80
Nikolaevsk	53	0.59	0.47	0.67	1.15	1.30	1.54	2.05	3.07	2.76	1.70	1.26	0.79	17.60
Okhotsk	23	0.08	0.08	0.16	0.35	0.79	1.69	2.32	2.44	2.01	0.95	0.16	0.12	11.14
Paris	38	1.54	1.22	1.61	1.65	2.09	2.32	2.20	2.16	1.97	2.32	1.81	1.73	22.60
Petropavlovsk	35	3.00	2.00	2.70	2.30	1.80	2.10	3.10	3.40	3.10	3.60	2.60	2.60	32.30
Rostov	26	1.38	1.42	1.30	1.34	1.69	2.44	2.20	1.22	1.22	1.30	1.50	1.54	18.55
Samarovo	10	0.30	0.60	0.70	0.50	2.00	2.30	2.40	3.00	2.20	1.60	1.00	1.00	18.00
Sredne Kolymsk	13	0.30	0.40	0.20	0.20	0.20	0.90	1.30	1.20	0.80	0.50	0.50	0.40	6.90
Tiksi	7	0.10	0.10	0.10	0.10	0.10	1.20	1.30	1.10	0.80	0.20	0.20	0.10	5.35
Uralsk	26	0.70	0.60	0.60	0.60	1.40	1.50	1.20	1.20	1.30	1.20	1.10	0.90	12.30
Verkhoyansk	31	0.20	0.10	0.10	0.20	0.30	0.90	1.00	1.00	0.50	0.30	0.30	0.20	5.05
Vilyusk	24	0.34	0.30	0.28	0.27	0.39	1.23	1.38	1.60	1.07	0.65	0.53	0.39	8.93
Vrangelya O.	9	0.43	0.24	0.29	0.24	0.31	0.53	0.89	0.89	0.64	0.50	0.27	0.23	5.46
Warszawa	M	1.50	1.50	1.40	1.40	1.30	1.30	1.50	1.30	1.10	1.20	1.40	1.50	16.40

M - Missing

TABLE XII: MEAN RELATIVE HUMIDITY (%)

Station	Yrs. Rec.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arkhangelsk	25	88	87	83	76	73	78	74	86	85	87	90	89	82
Barnual	10	81	80	75	70	58	63	68	71	75	76	82	82	73
Berezevo	8	85	82	73	71	70	72	73	80	81	85	84	85	78
Borno	18	74	73	73	68	68	74	76	75	76	75	76	74	74
Borzya	3	80	82	74	58	48	53	67	67	65	62	78	80	68
Budapest		Not available												
Dikson O.	19	89	88	85	88	88	91	90	90	89	88	88	86	88
FORT CHURCHILL	10	91	90	90	89	85	78	72	72	85	86	93	94	85
FAIRBANKS, ALASKA*	15	69	68	66	61	58	62	70	76	76	79	73	71	69
Gizhiga	1 - 3	74	86	79	81	81	81	79	81	77	82	77	78	80
Helsinki	26	87	87	82	78	71	72	73	80	83	86	88	89	81
Igarka		Not available												
Irkutsk	M	82	77	70	59	56	61	72	76	75	75	82	86	72
Matochkin Shar	16	81	82	82	81	79	79	78	81	83	83	83	83	81
Moskva	10	84	82	78	59	59	68	68	73	80	80	84	85	75
Mys Chelyuskin	7	86	85	82	84	86	90	90	94	90	87	84	82	87
Nikolaevsk	9	81	79	77	78	80	80	81	83	80	76	76	82	79
Okhotsk	12	68	65	68	[illegible]	83	89	87	86	76	64	62	64	74
Paris	10	84	79	71	67	66	65	64	67	72	79	85	85	74
Petropavlovsk	35	78	77	77	78	81	85	88	87	84	76	74	81	80
Rostov	M	86	87	84	68	62	65	59	55	63	73	84	88	72
Samarovo	17	79	79	71	68	68	67	71	77	81	84	85	85	76
Sredne Kolymsk	6	78	78	76	71	70	65	68	78	78	83	84	82	76
Tiksi	3	78	82	76	80	82	82	82	94	82	82	73	76	80
Uralsk	M	88	88	87	75	56	60	59	60	66	79	87	91	75
Verkhoyansk	9	72	71	67	60	55	53	59	69	75	77	76	74	67
Vilyusk	12	81	81	72	62	60	60	61	69	74	80	83	79	72
Vrangelya O.	8	86	84	84	84	85	89	75	92	88	86	84	87	85
Warszawa		Not available.												

*Substitute Station. Fort Greely data not available.

M - Missing

TABLE XIII: MEAN NUMBER OF DAYS WITH FOG

TABLE XIII: MEAN NUMBER OF DAYS WITH FOG

Station	Yrs. Rec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Arkhangelsk	10	3	3	3	2	1	*	1	2	2	4	3	3	27
Barnual	10	8	10	8	4	1	1	2	5	6	6	6	8	63
Berezevo	8	2	1	1	1	1	*	*	1	2	2	1	2	12
Borno	14	*	*	1	1	2	3	3	2	1	1	*	*	14
Borzya	9	1	1	1	*	0	*	0	*	0	1	*	1	5
Budapest						Not available								
Dikson O.	20	4	4	5	7	7	15	20	16	11	5	3	2	99
FORT CHURCHILL	10	1	1	*	1	1	4	2	2	1	*	*	0	13
FAIRBANKS, ALASKA**	27	5	4	*	*	*	*	1	1	1	2	2	4	20
Gizhiga	14	1	*	*	1	2	6	7	7	3	1	*	1	29
Helsinki	36	9	8	9	8	4	2	2	2	7	10	8	8	77
Igarka	M	5	4	2	0	1	2	4	3	4	5	2	6	38
Irkutsk	M	9	3	2	1	1	2	4	6	6	5	10	16	65
Matochkin Shar	16	4	2	2	3	3	7	8	10	10	5	3	3	60
Moskva	10	2	2	2	2	*	*	*	1	2	4	3	3	22
Mys Chelyuskin	3	4	6	11	10	9	14	24	25	15	8	8	1	135
Nikolaevsk	M	*	*	1	2	3	1	1	2	3	1	*	*	14
Okhotsk	5	0	0	1	2	7	13	11	7	3	*	0	0	44
Paris	15	12	9	6	3	3	1	1	2	6	6	11	11	71
Petropavlovsk	15	*	*	1	4	11	15	17	13	7	2	1	*	71
Rostov	10	5	4	4	1	*	*	*	*	1	4	6	7	33
Sararovo	5	5	0	0	0	0	*	0	0	1	1	0	0	2
Sredne Kolymsk	8	3	2	1	*	1	*	1	3	2	2	1	2	18
Tiksi	3	4	6	5	6	6	15	10	5	5	4	1	2	69
Uralsk	10	1	2	2	1	0	0	0	0	*	1	2	2	11
Verkhoyansk	9	3	2	1	*	1	*	1	5	4	1	2	4	24
Vilyuk	10	4	2	1	*	*	*	*	1	1	1	1	5	16
Vrangelya O.	10	4	4	4	7	10	15	17	16	8	4	4	4	96
Warszawa						Not available								

*Less than 0.5 days
**Substitute station. Fort Greely data not available

7. Limitations of Analyses and Definitions of Terms

a. Limitations

The procedures outlined in the discussions of individual elements have certain limitations which affect reliability of the analyses. These are listed below.

(1) Climatic data are lacking for large parts of the study area. This is especially true for the Central Siberian Plateau.

(2) Many arctic stations have extremely short climatic records, and periods of record are variable over most of the study area. Adjustment of records to a standardized period was not practicable.

(3) In some cases data were not given or observed at times or in a form similar to those for Fort Churchill and Fort Greely.

(4) Descriptions of most station sites were not available, making it impossible to ascertain the extent of the area for which data of each station can be considered representative.

b. Definitions

The climatic elements presented in the report are defined below.

Mean Temperature - In Europe and the U S S R the arithmetic mean of three daily temperature observations, usually at 0700, 1300, and 2100 hours, for all days of the month concerned; at Fort Churchill and Fort Greely the arithmetic mean of maximum and minimum temperatures for all days of the month concerned.

Mean Daily Minimum Temperature - The arithmetic mean of minimum temperatures on all days of the month concerned.

Mean Daily Maximum Temperature - For Fort Churchill and Fort Greely, the arithmetic mean of maximum temperatures for all days of the month concerned; for stations in the study area, when the mean 1300 hour temperature was reported as the mean daily maximum, an estimated mean daily maximum was computed. This was done by subtracting the mean daily minimum temperature from twice the mean temperature reported for this station.

Absolute Minimum Temperature - The lowest temperature ever observed at the station.

Highest Reported Temperature - For Fort Churchill and Fort Greely, the absolute maximum temperature. For stations in the study area, the highest temperature reported. In many cases this is the highest temperature observed at 1300 hours.

Mean Wind Speed - The arithmetic mean of all observations for the month concerned, in miles per hour.

Mean Cloudiness - The arithmetic mean of all observations of cloud cover in tenths of total sky covered for the month concerned.

Mean Snow Depth - The arithmetic mean of snow accumulation measurements (usually taken at beginning and end of month or at three 10-day intervals during each month) in inches.

Mean Annual Precipitation - The arithmetic mean of total precipitation amounts for all years of record, in inches.

Mean Relative Humidity - The arithmetic mean of all daily relative humidity observations for all days of the month concerned. Relative humidity is the ratio of the quantity of water vapor actually present to the greatest amount possible at a given temperature, in percent.

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9. Maps

Figure 1: Station Locations

Figure 2: Major Physical Features

Figure 3: Mean Temperature, Coldest Month

Figure 4: Mean Daily Minimum Temperature, Coldest Month

Figure 5: Absolute Minimum Temperature

Figure 6: Mean Windchill, Coldest Month

Figure 7: Mean Cloudiness, Coldest Month

Figure 8: Mean Snow Depth, Month of Greatest Depth

Figure 9: Mean Temperature, Warmest Month

Figure 10: Mean Daily Maximum Temperature, Warmest Month

Figure 11: Mean Cloudiness, Warmest Month

Figure 12: Mean Annual Precipitation

Figure 12a: Mean Number of Days with Fog

Figure 13: Composite Analogous Areas, Coldest Month

Figure 14: Composite Analogous Areas, Fort Greely

Figure 15: Composite Analogous Areas, Fort Churchill

MAP ERRATA

Figure 3

Temperature value for Syzran, USSR is 8°F.
Temperature value for Svyatoy Nos, USSR is 17°F.
Change temperature value at Irbit, USSR from -1° to 1°F.
Temperature value for Chainskoe Pole, USSR, is -7°F.
Change value at Verkhoyansk, USSR, from 58° to -58°F.
Change value at Klyuchi, USSR, from 18° to 19°F.

Figure 4

Temperature value for Narym, USSR is -18°F.
Temperature value for Mys Vankarem, USSR is -20°F.

Figure 5

Temperature for Povonets, USSR is -37°F.

Figure 6

Wind speed value for Roros, Norway is 5 mph.

Figure 7

Change station circle at Khabarovsk, USSR from ⦶ to ●.

Figure 8

Delete station circle for Pinsk, USSR.

Figure 10

Delete station circle for Tiksi, USSR.

Figure 11

Add pattern to indicate analogy on the coast in the vicinity of Petropavlovsk (Kamchatka).

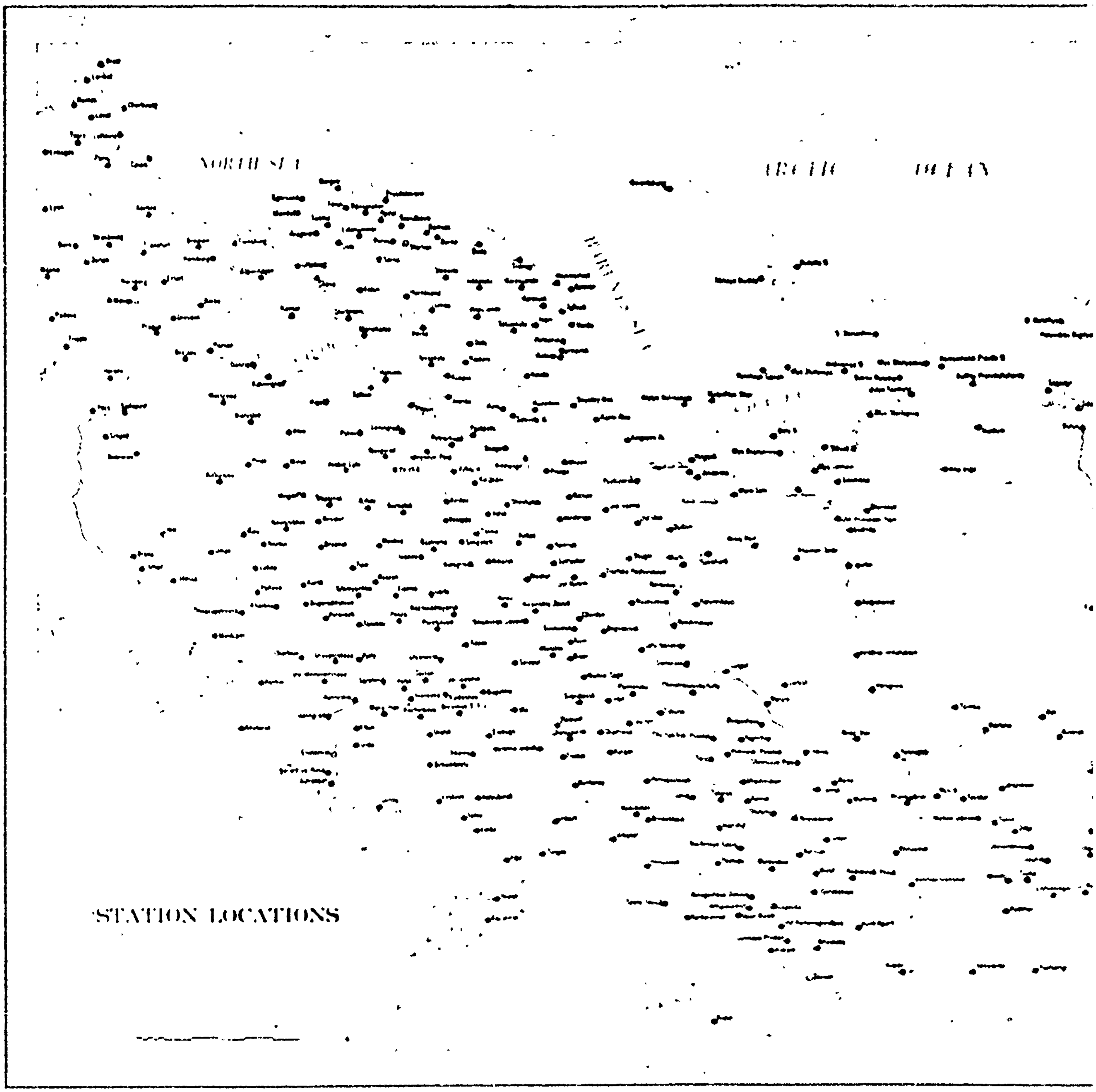
Figure 12

Change precipitation value at Paris, France from 26.6 to 22.6 inches.

Figure 12a

Change coldest month subscript at Pecs, Hungary from A (August) to JA (January).
Warmest month subscript for Kalmar, Sweden is J (July).
Change warmest month subscript at Vasa, Finland from F (February) to J (July).
Change data for the mean, foggiest month, at Berezevo, USSR from 25-0,D,JA to 2-S,0,D,JA.
Change coldest month subscript at Malye Karmakuly, USSR from A (August) to JA (January).
Change month subscript from M (May) to MA (March) at Mys Shelagskiy, USSR, and all stations west of the 120° E meridian at which an M appears.

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL



... AND FORT CHURCHILL – EURASIA

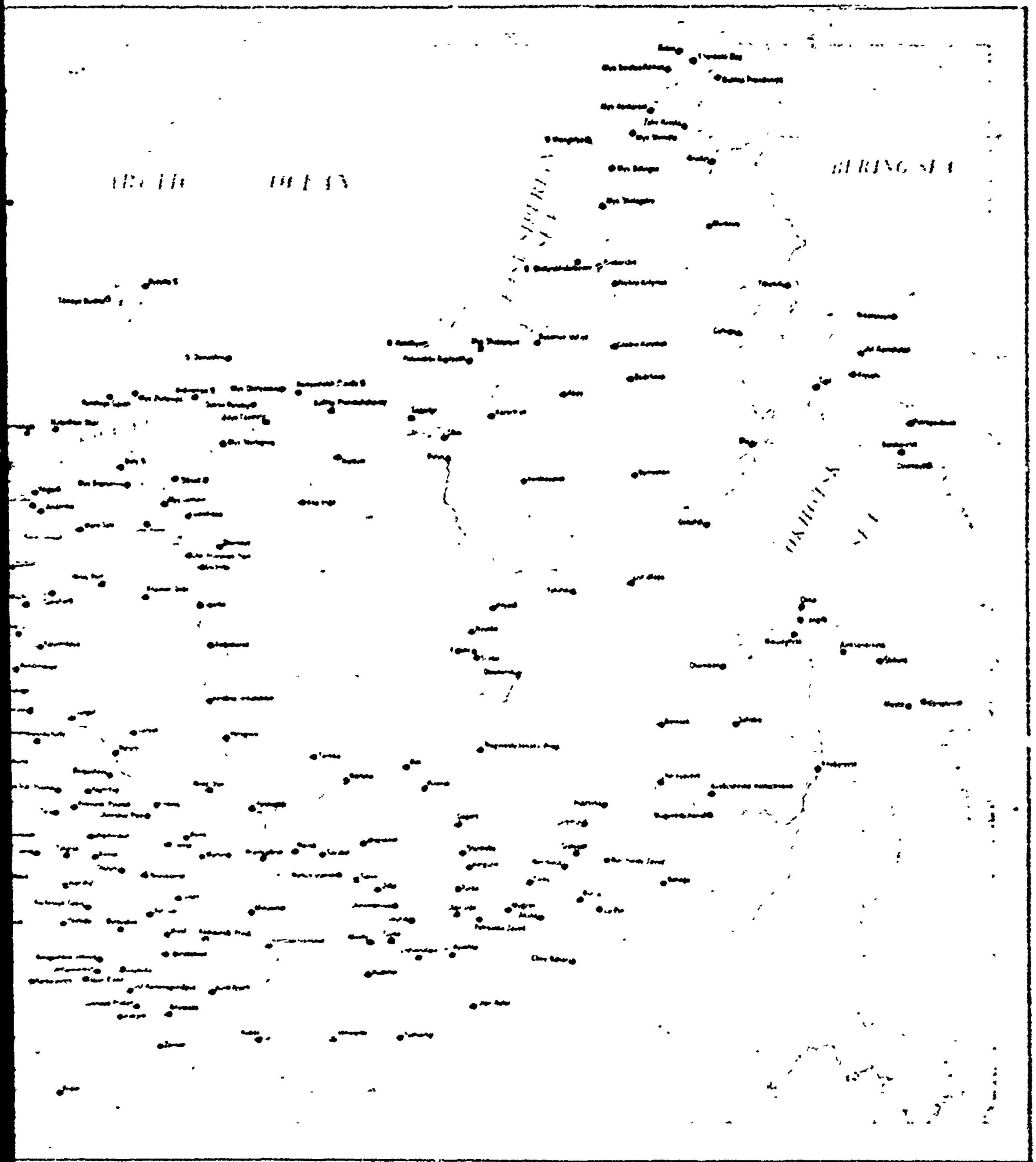
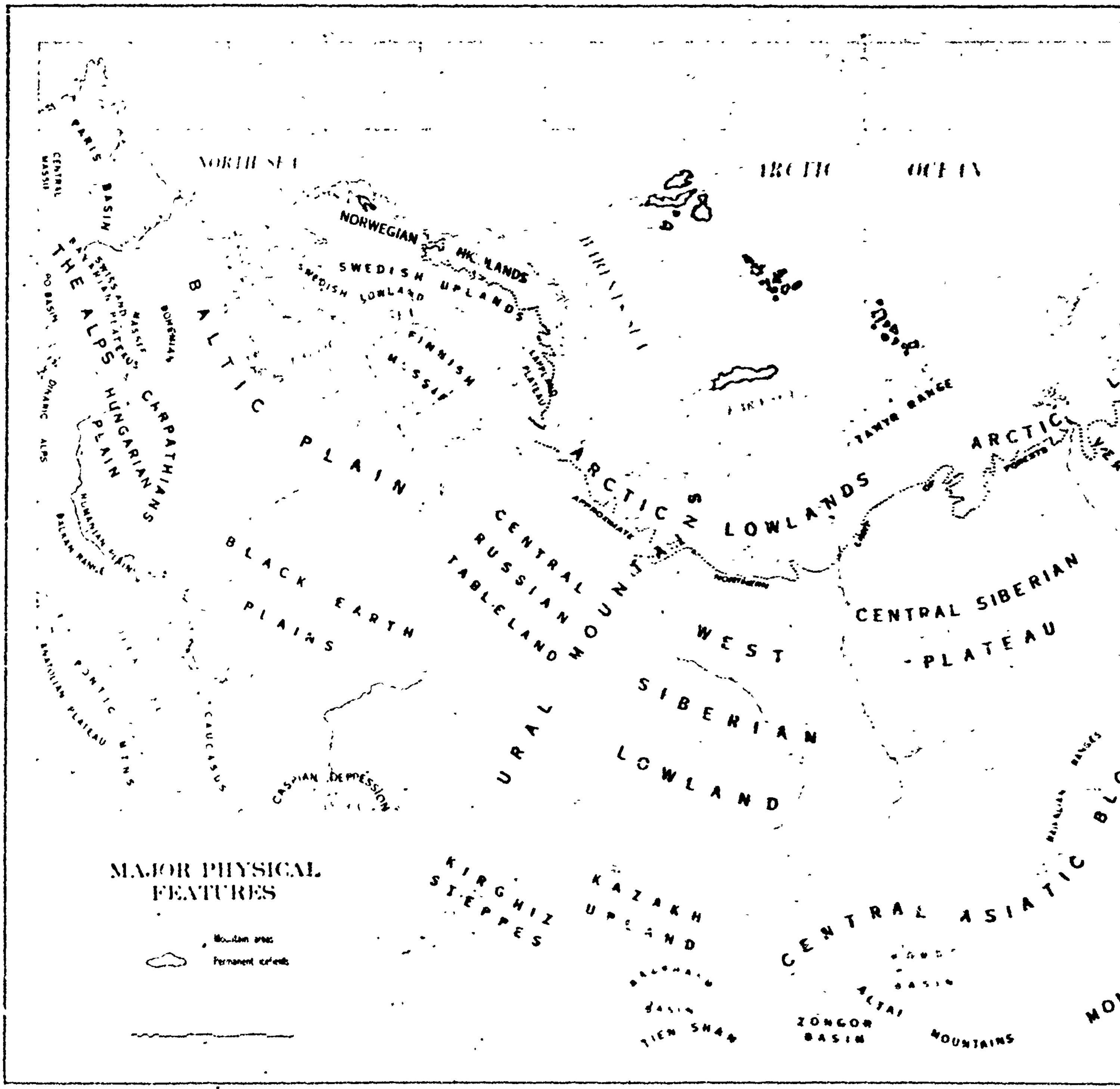
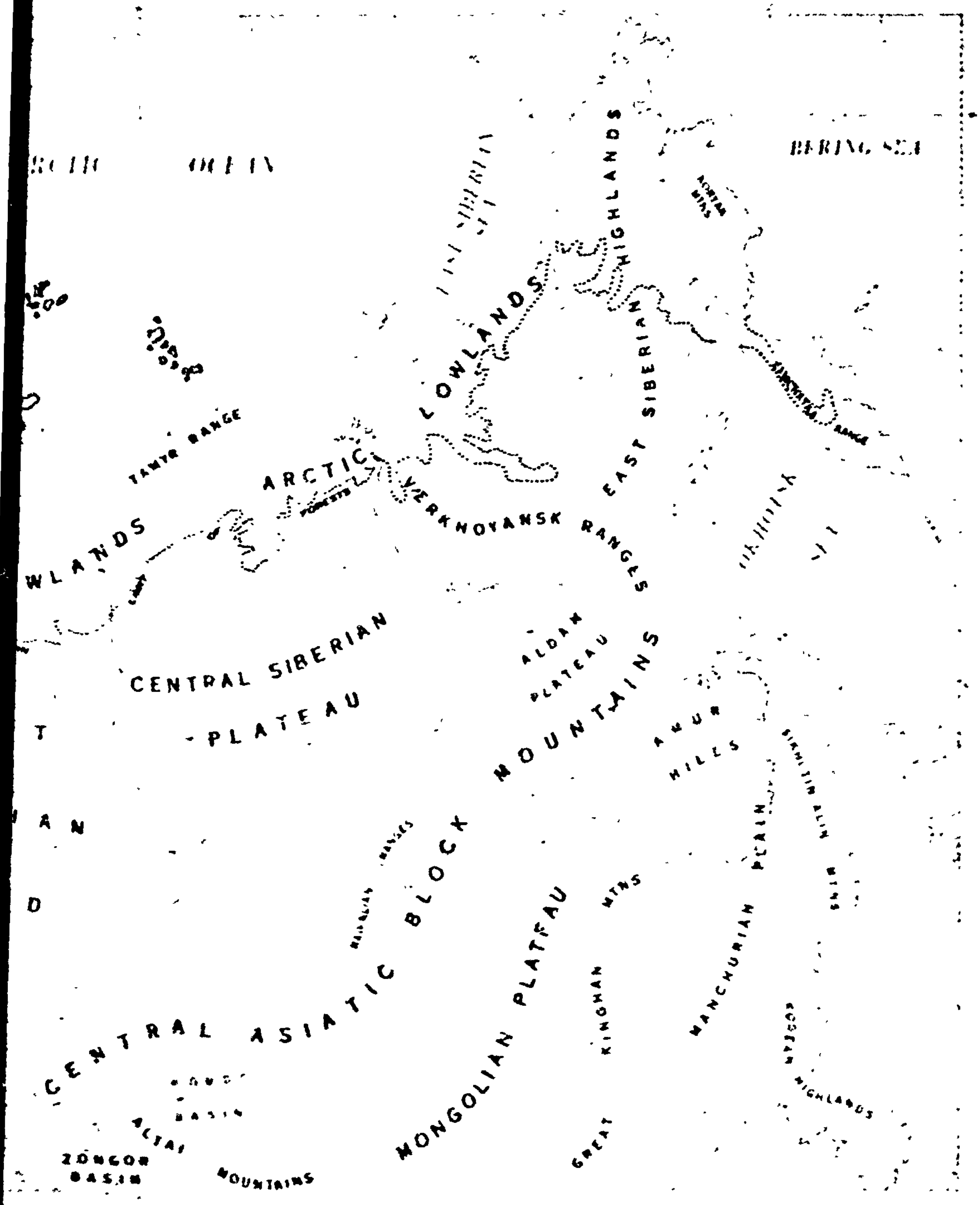


Figure 1

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL -

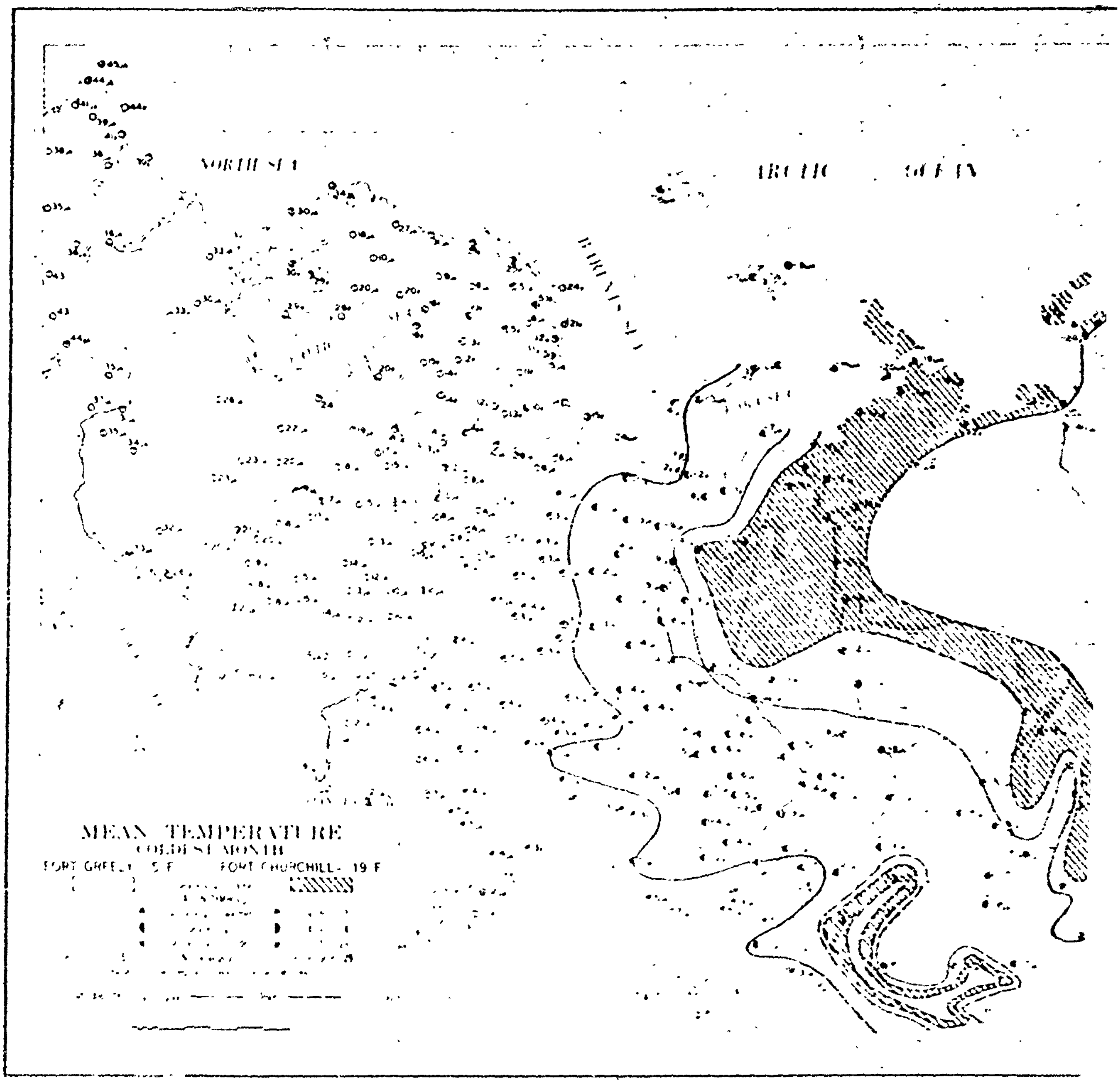


ND FORT CHURCHILL – EURASIA



2

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL



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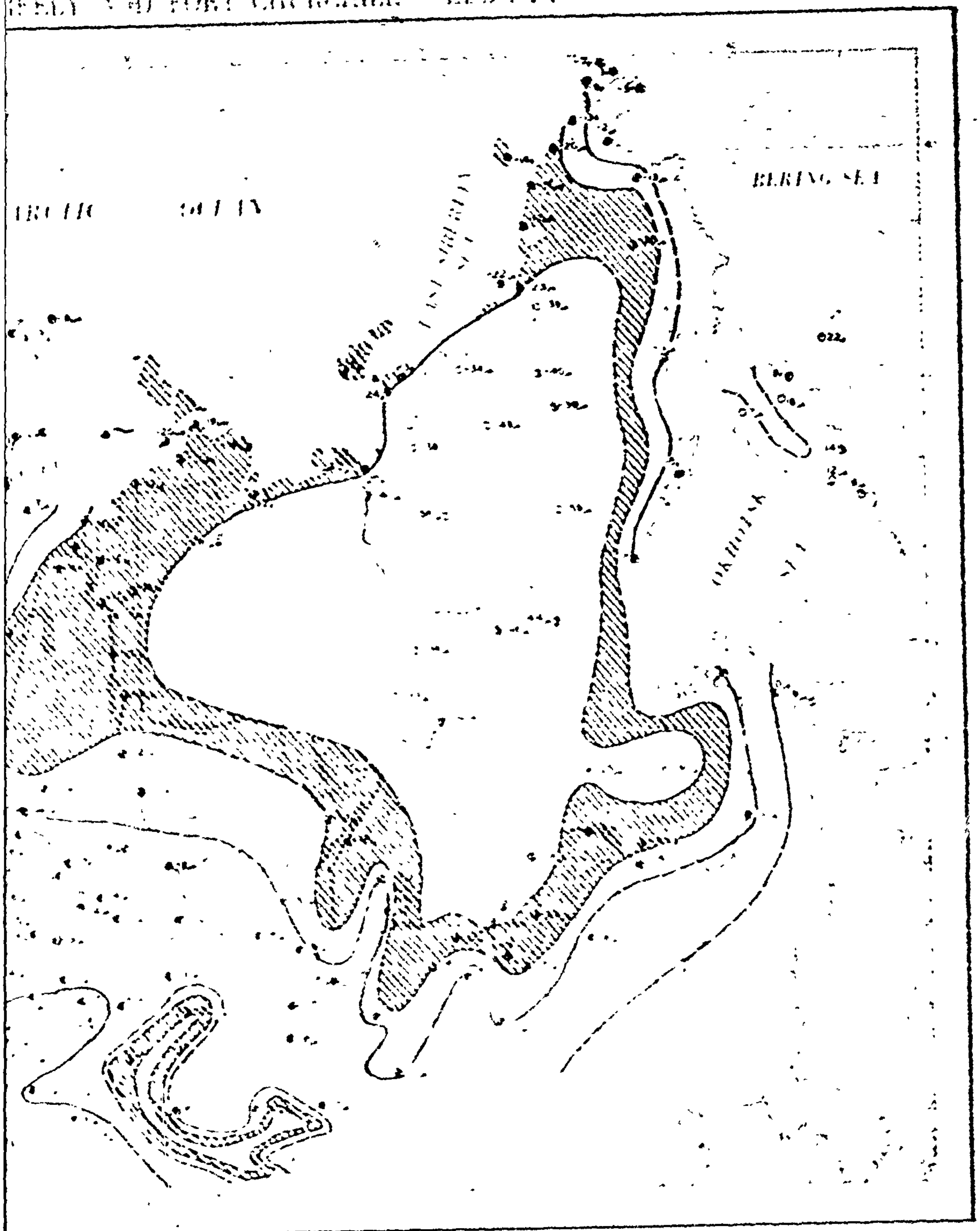

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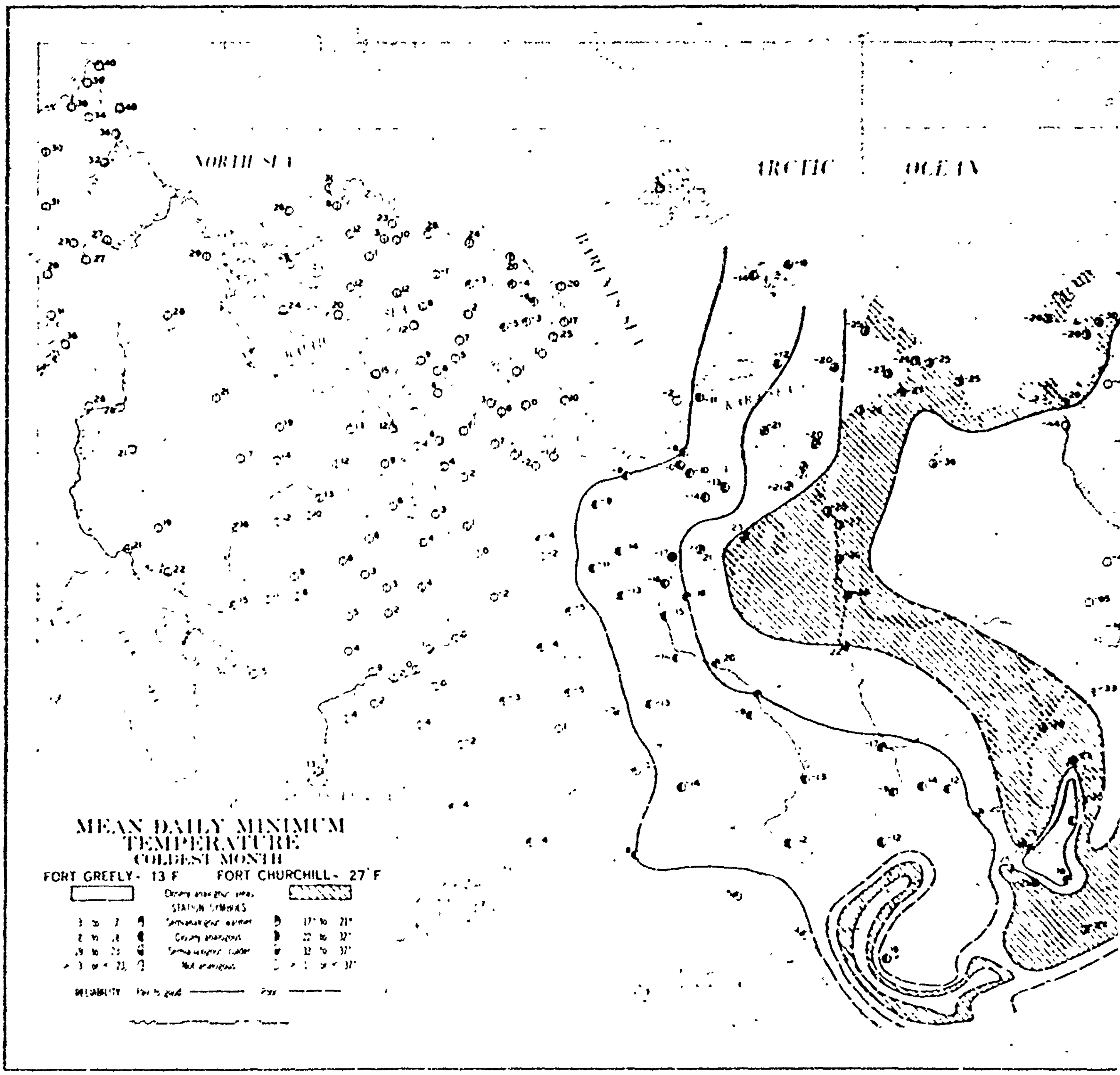

NORTH SEA
ARCTIC
OCEAN
MEAN DAILY MINIMUM TEMPERATURE
COLDEST MONTH
FORT GREELY - 13 F
FORT CHURCHILL - 27 F
STATION SYMBOLS
RELIABILITY

CREELY AND FORT CHURCHILL – EURASIA

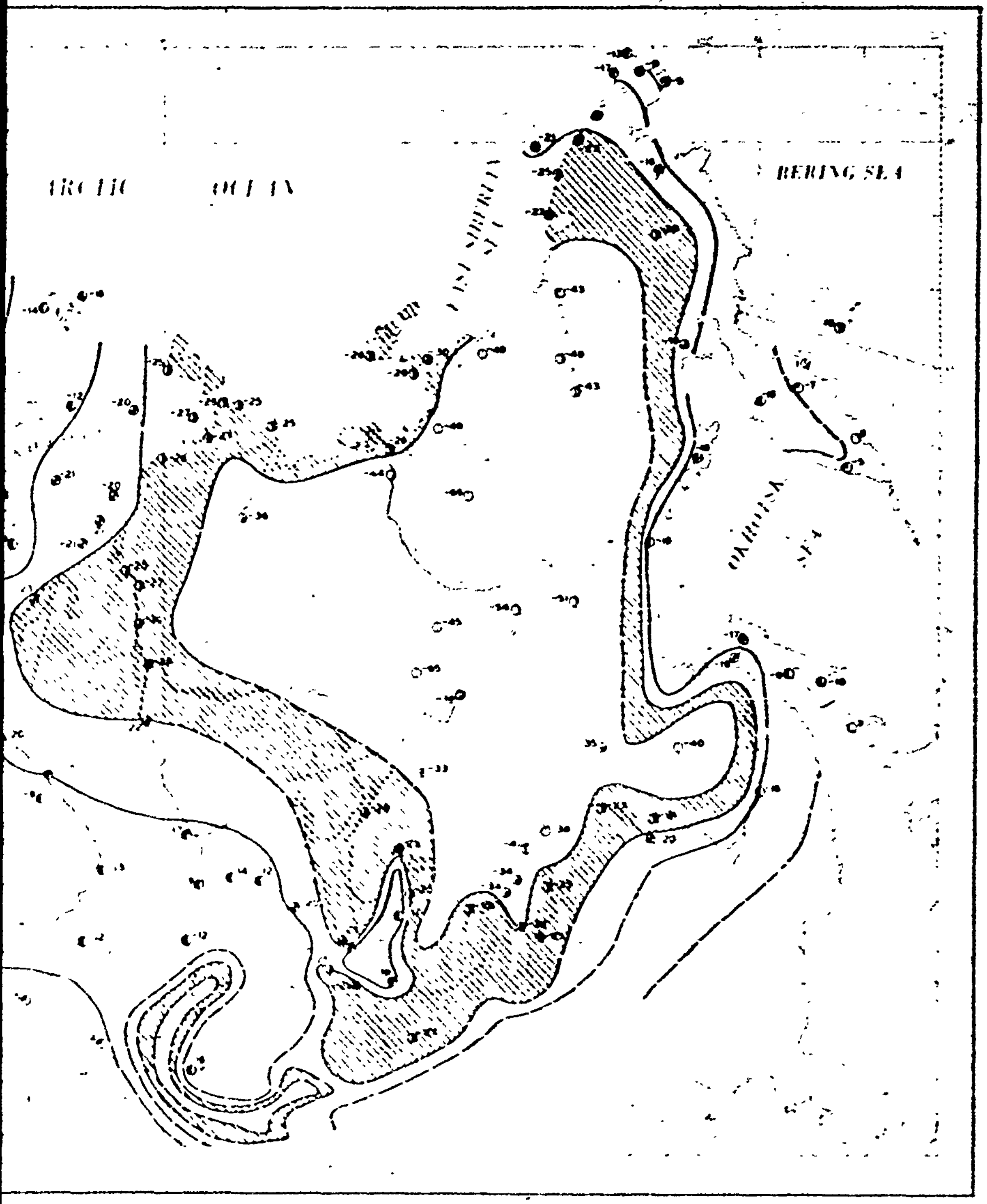
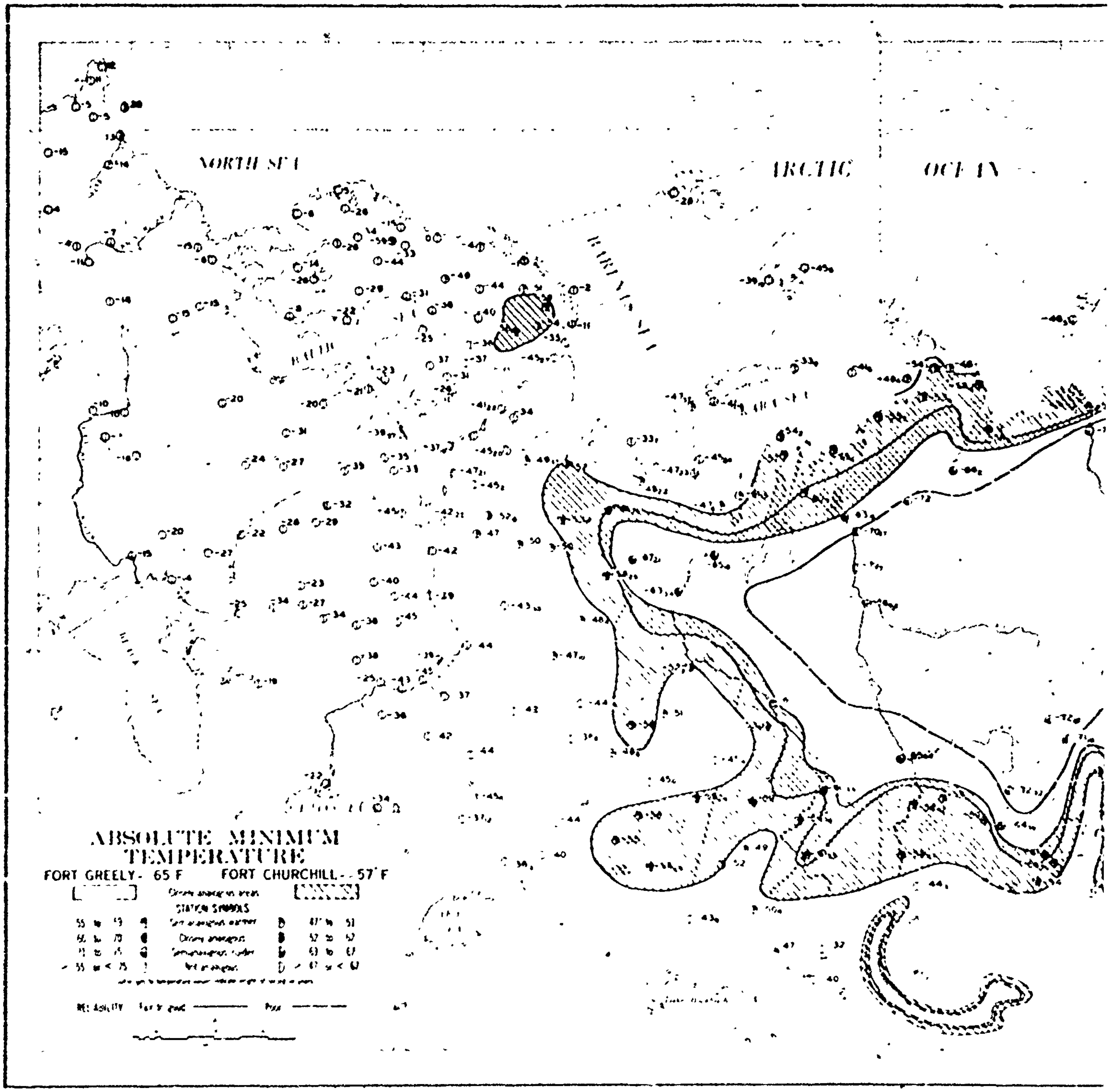


Figure 4

2

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHI



...S OF FORT GREELY AND FORT CHURCHILL – EURASIA

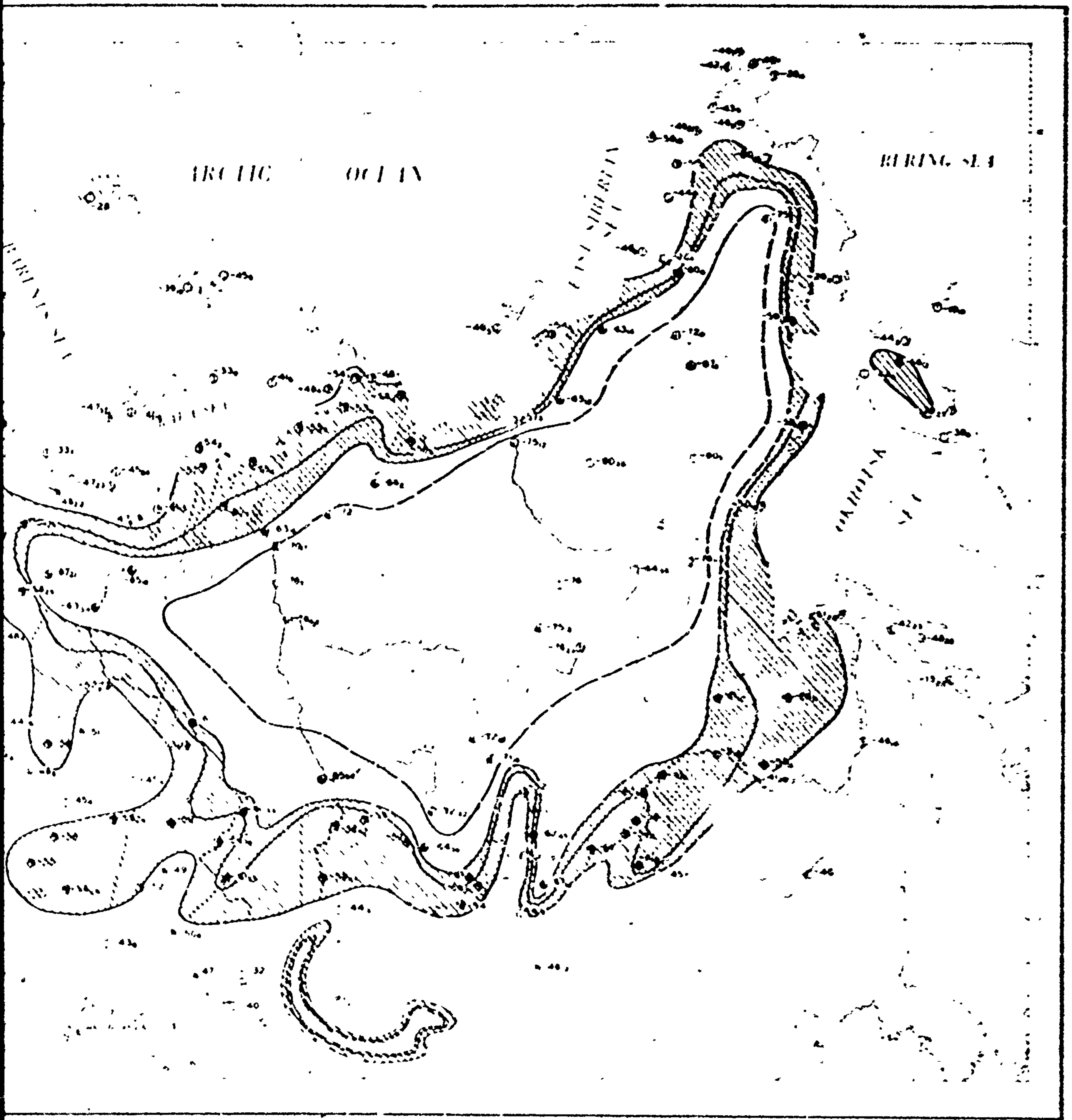
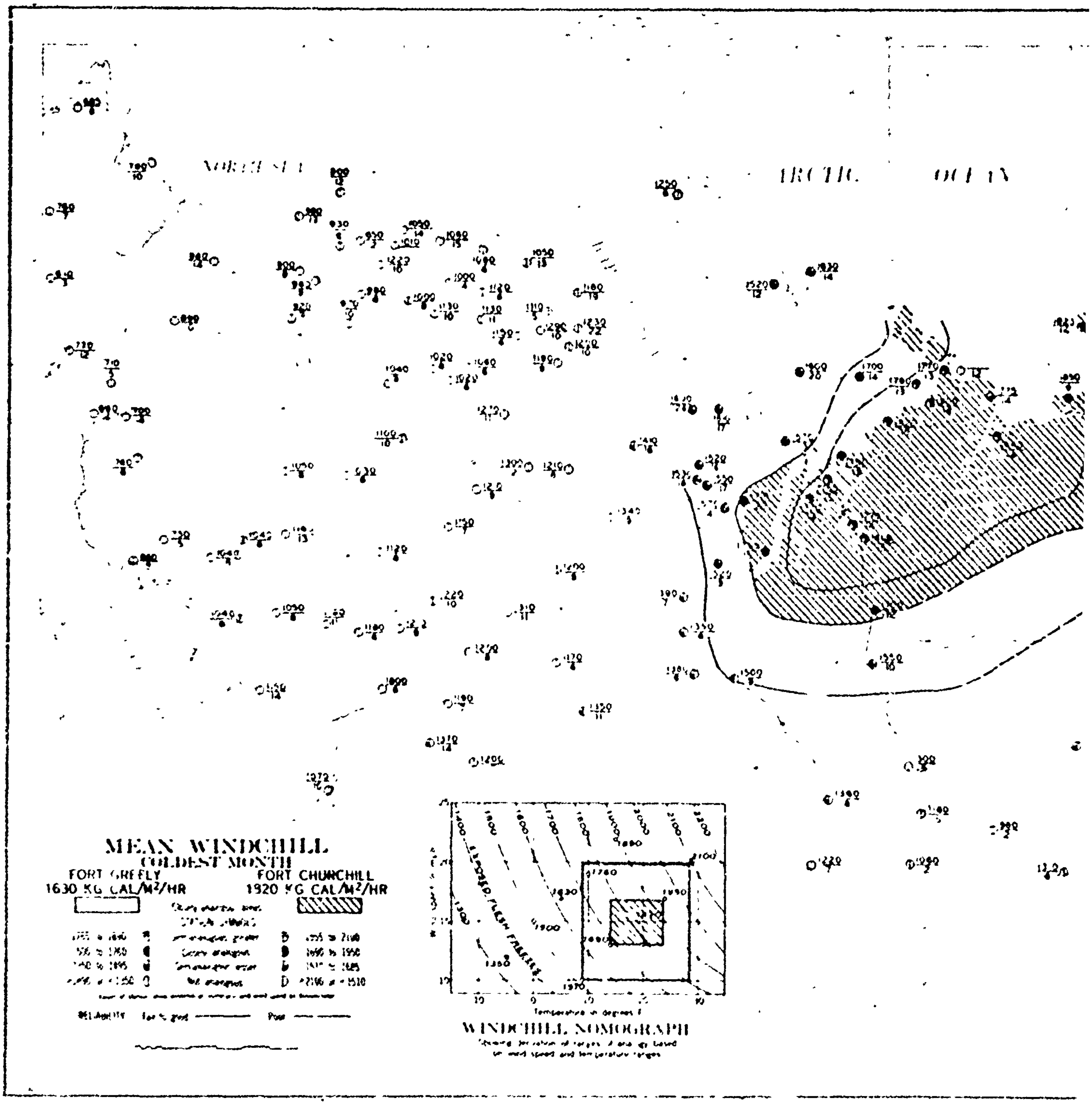


Figure 5

2

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL



CREELY AND FORT CHURCHILL – EURASIA

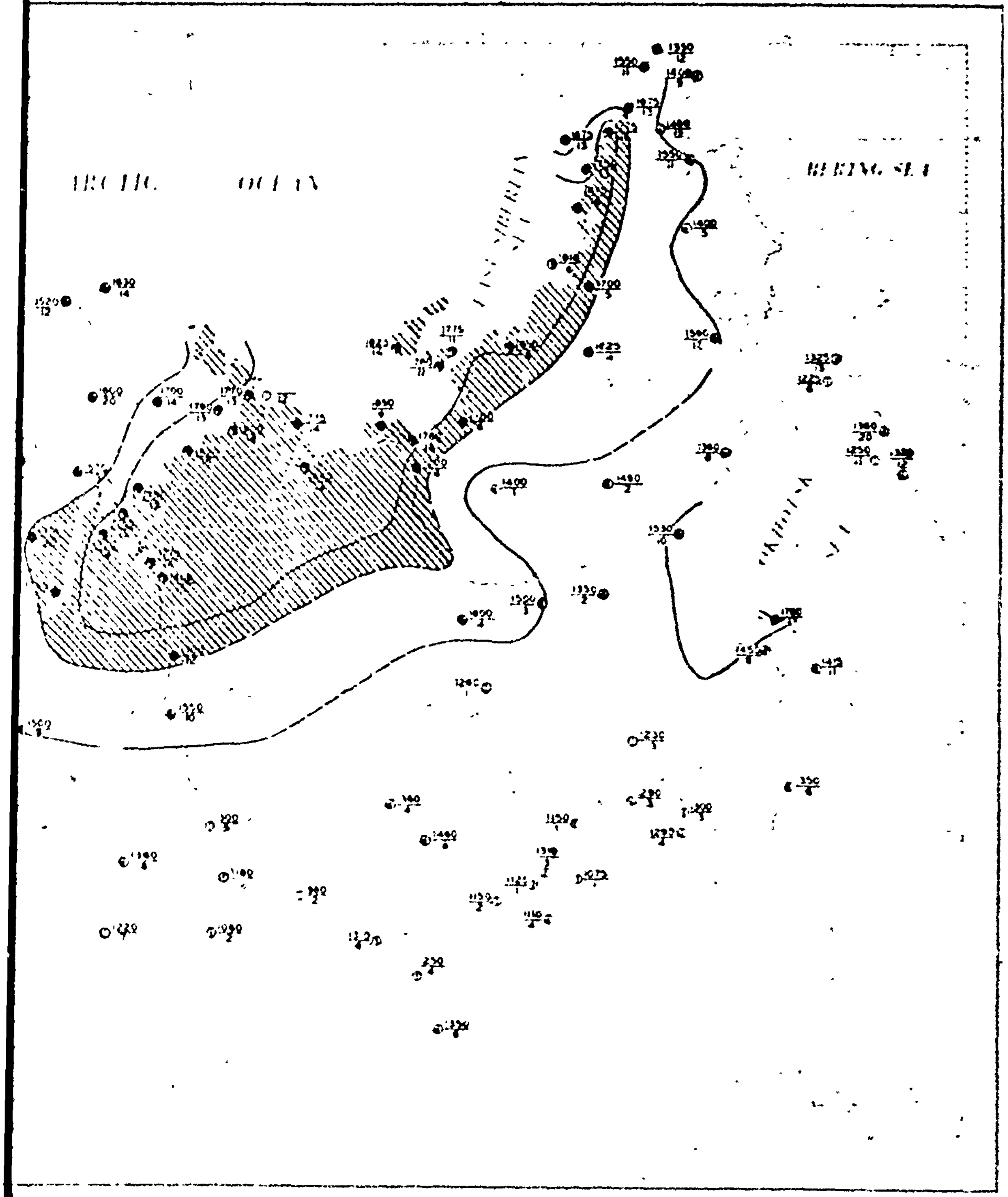
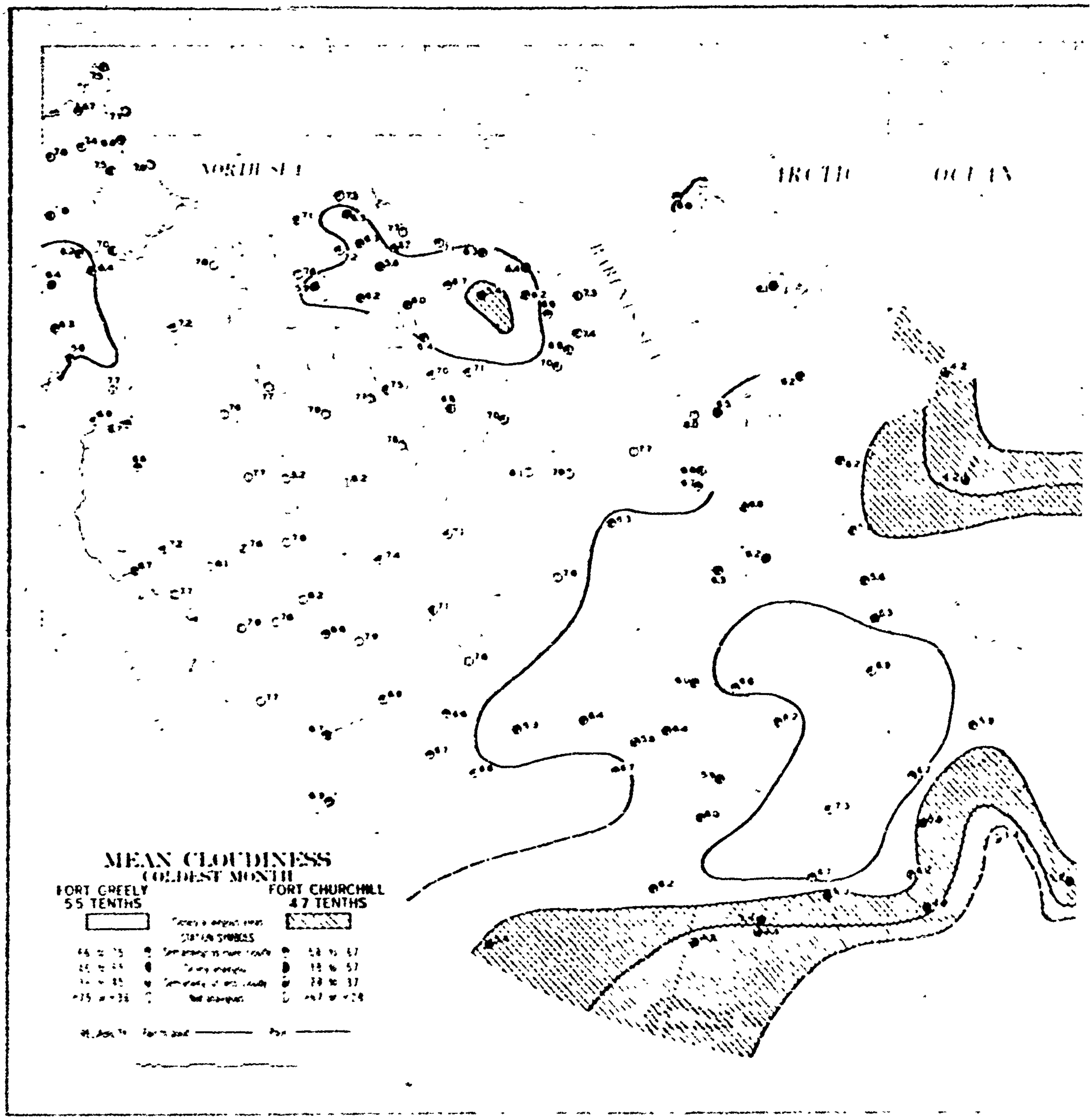


Figure 6

2

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURC



FORT GREELY AND FORT CHURCHILL – EURASIA

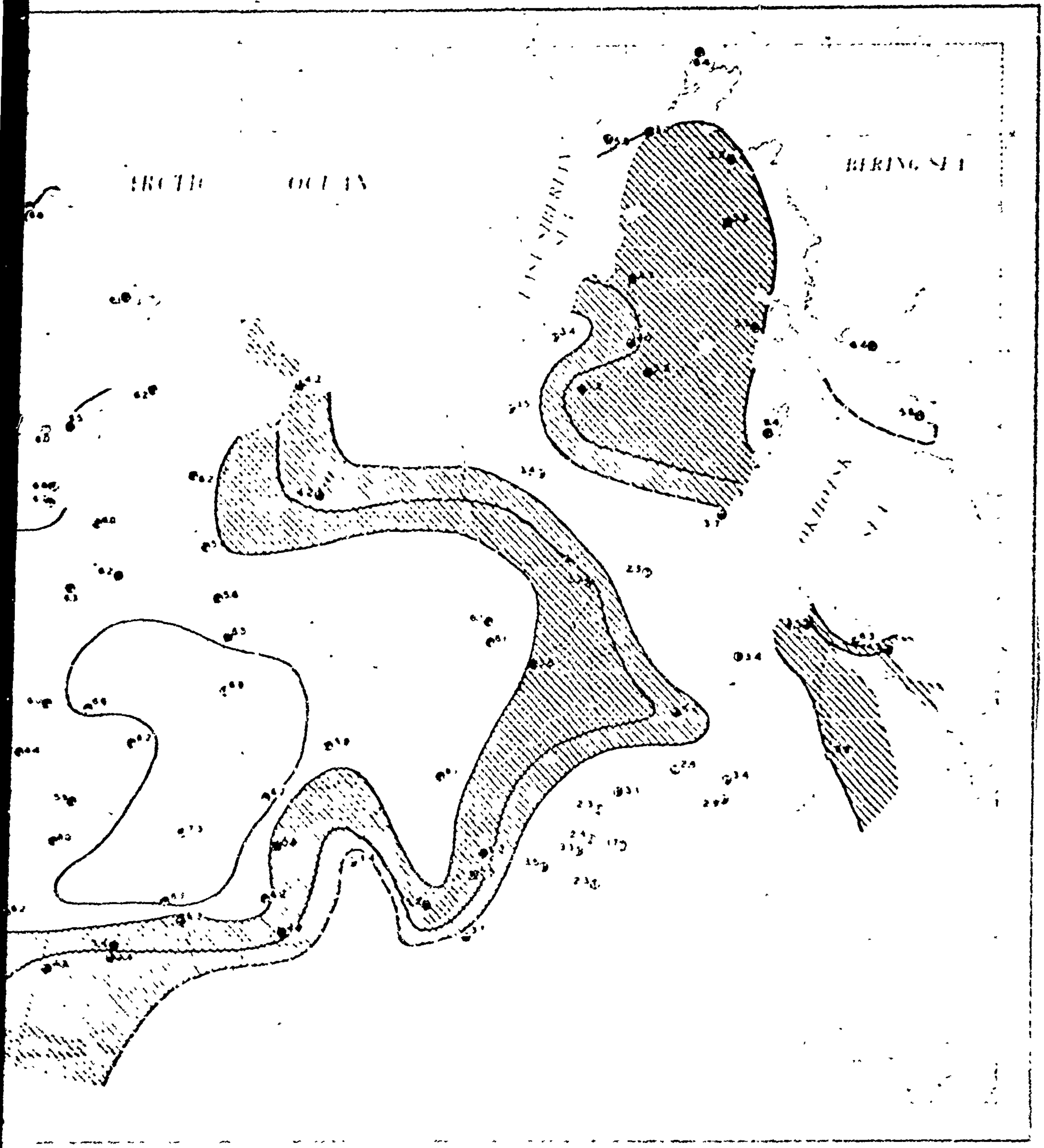
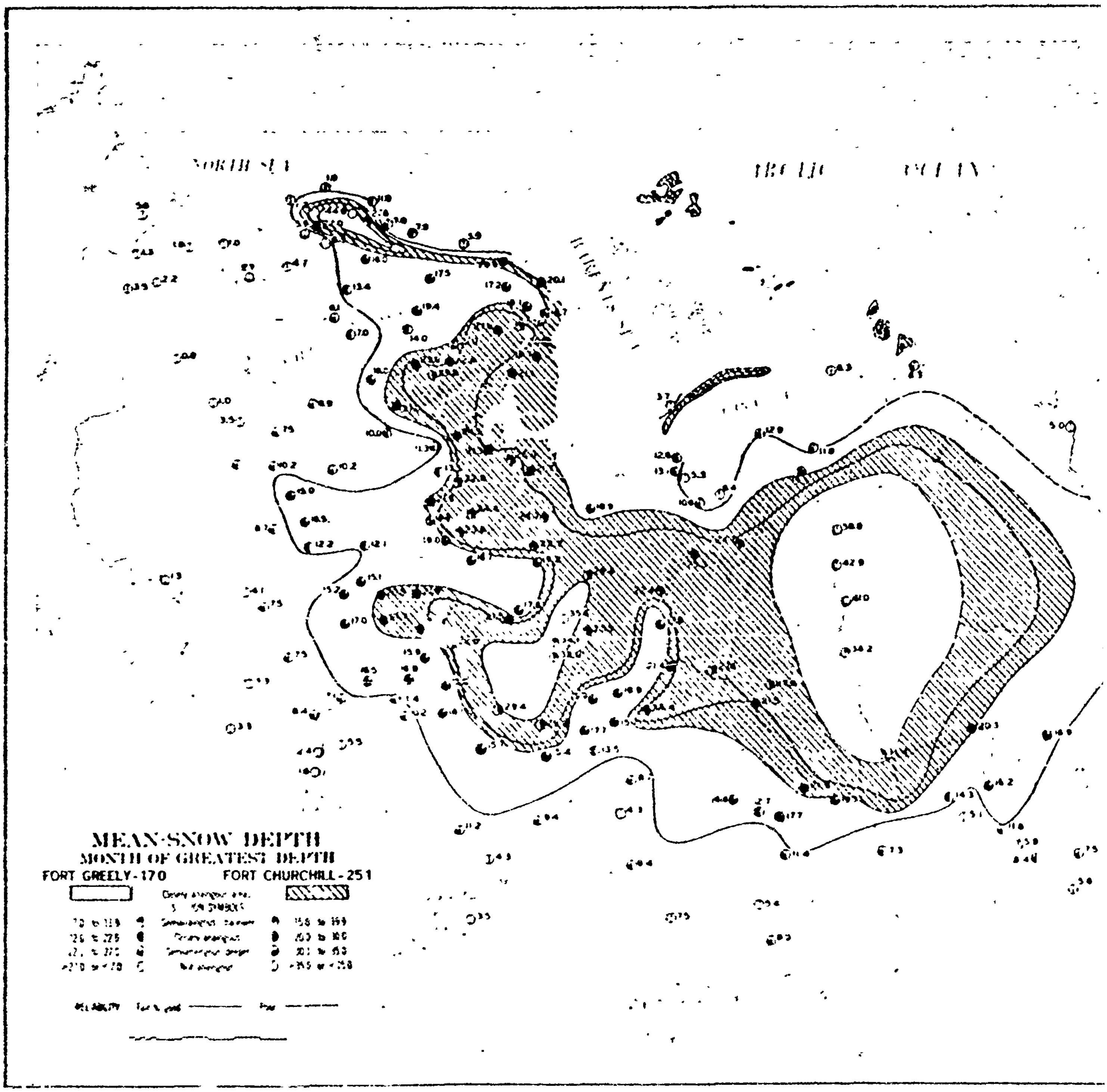
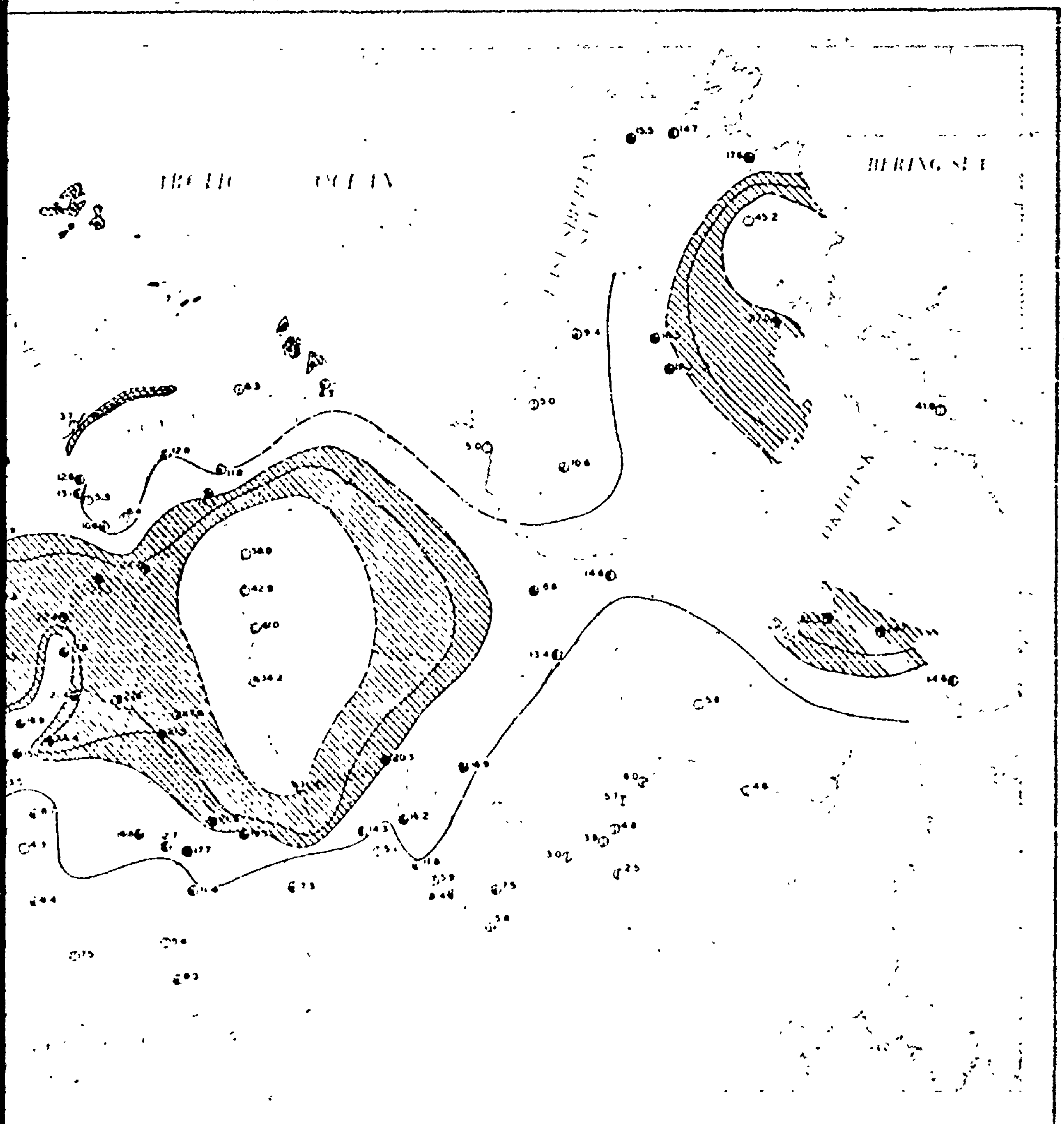


Figure 7

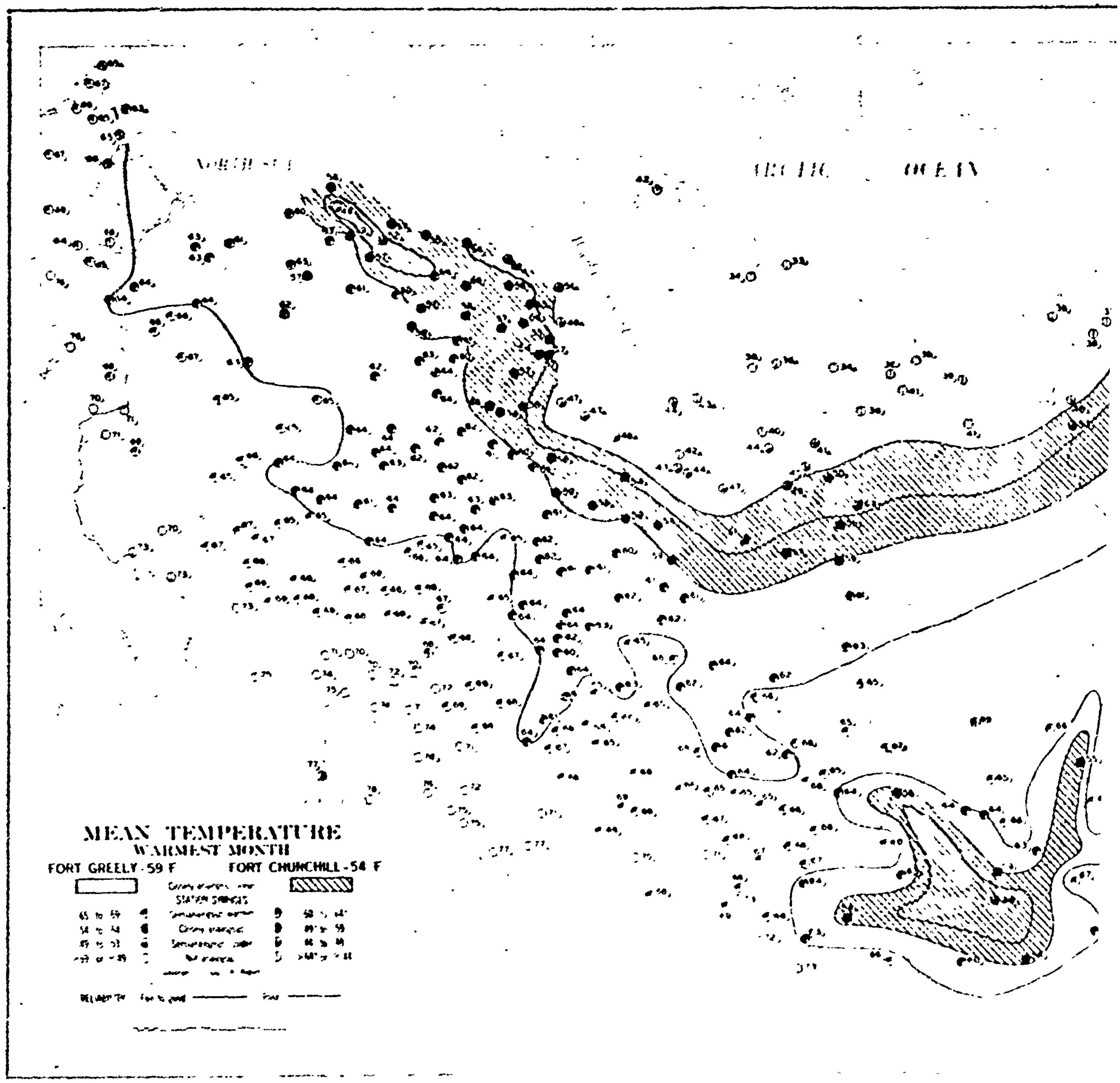

MEAN-SNOW DEPTH
MONTH OF GREATEST DEPTH
FORT GREELY-170
FORT CHURCHILL-251

OF PORT-EPPELY AND FORT CHURCHILL – EURASIA

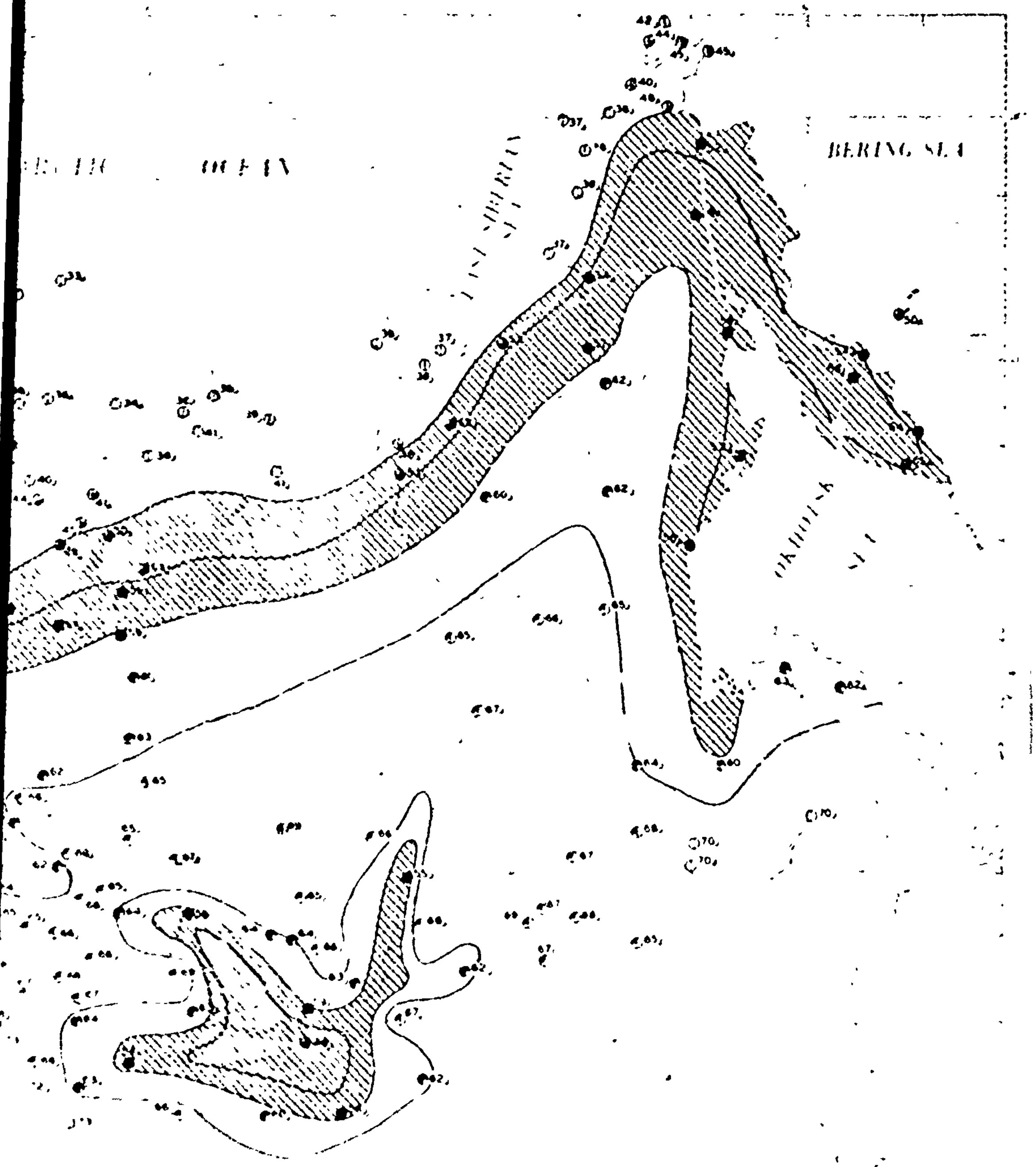


2

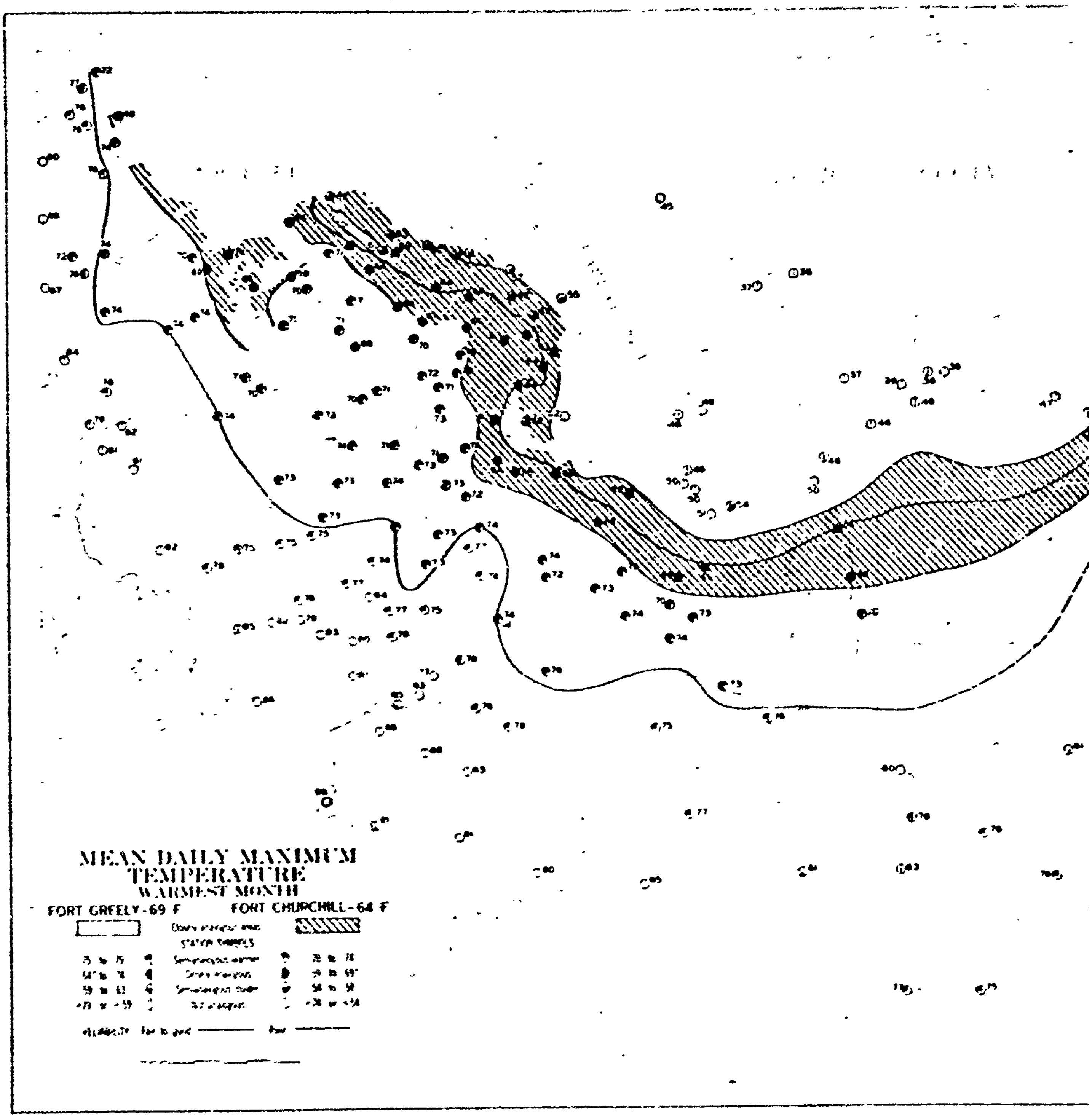
CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL

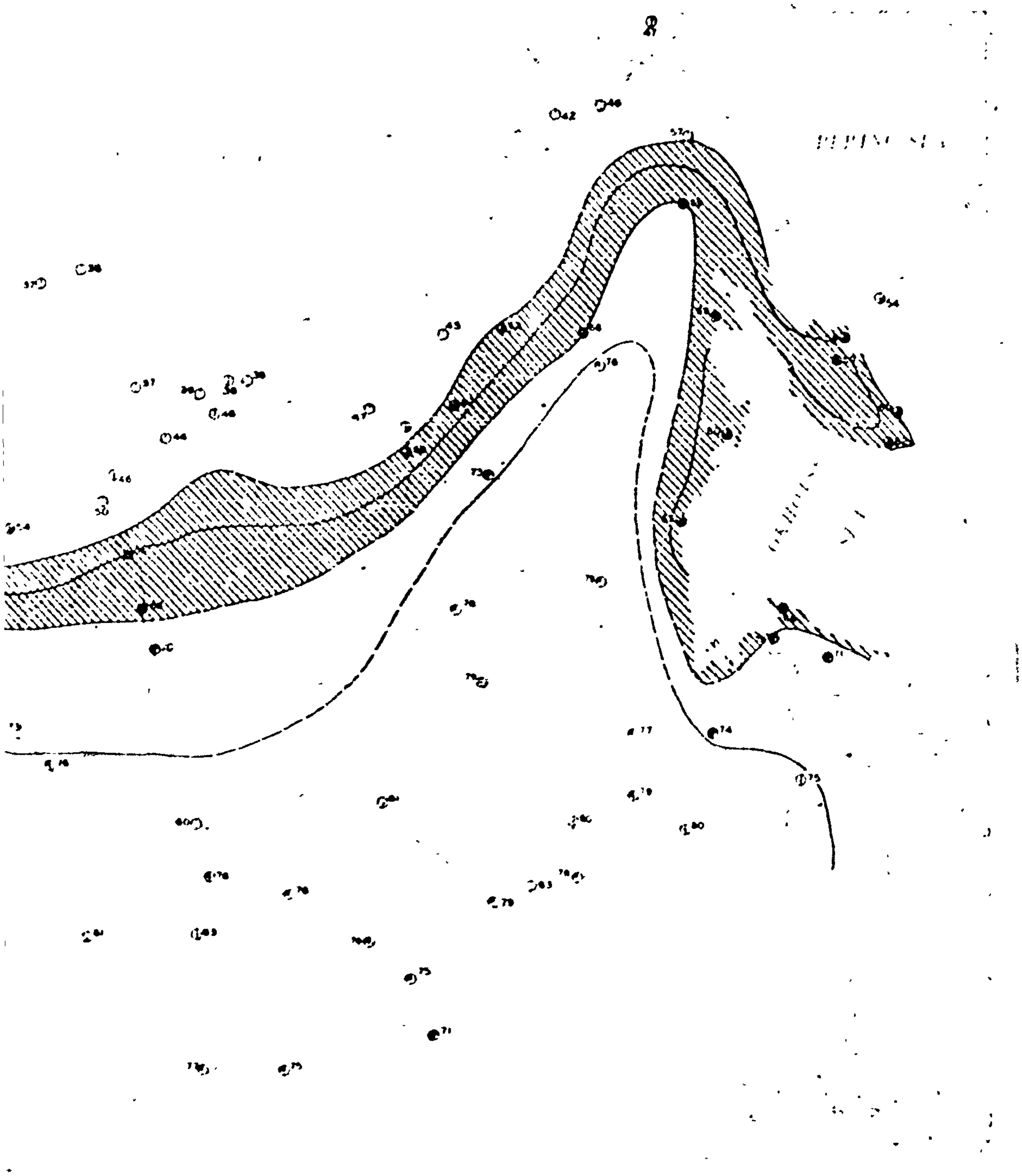


ELY AND FORT CHURCHILL – EURASIA

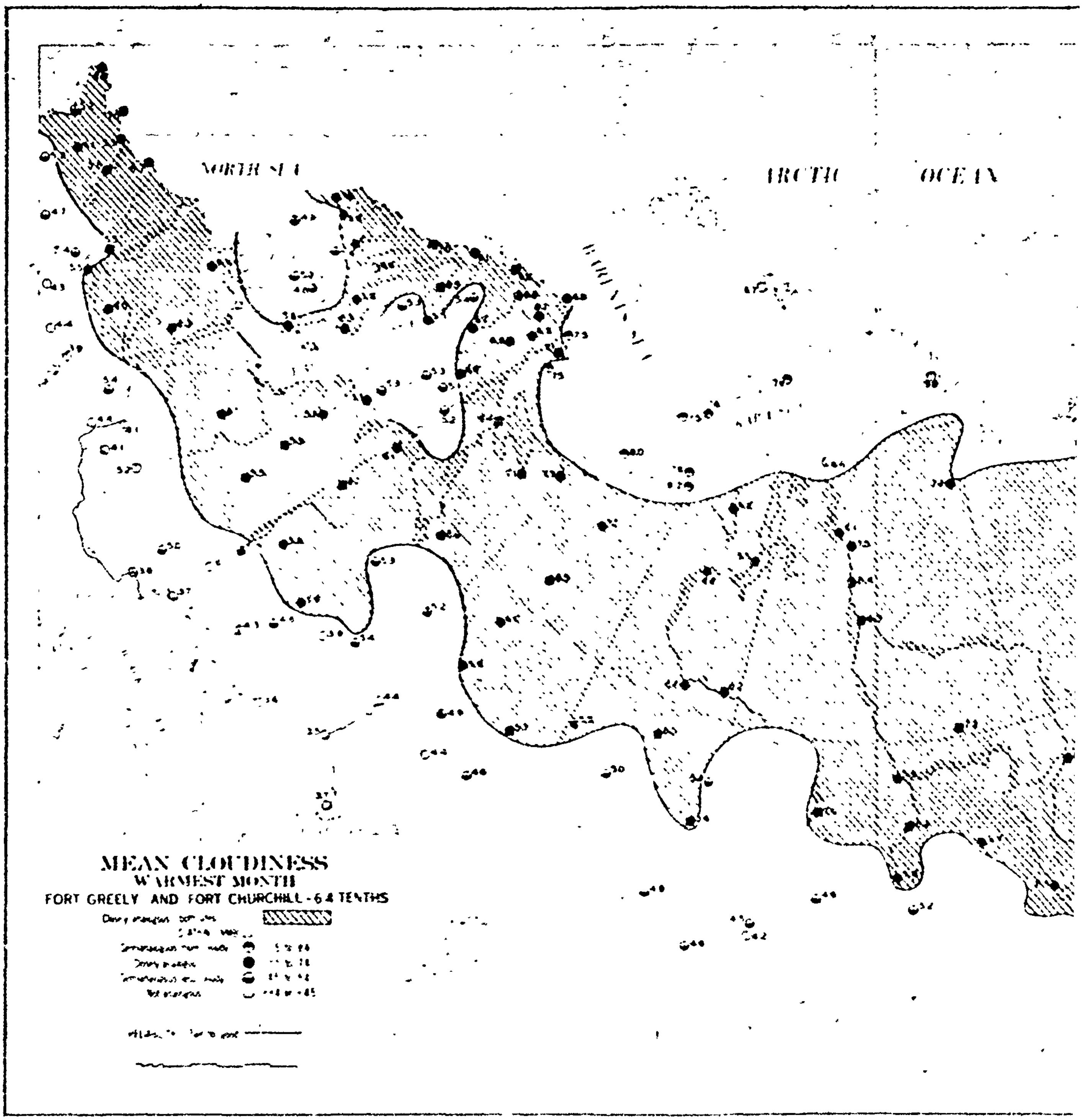


2

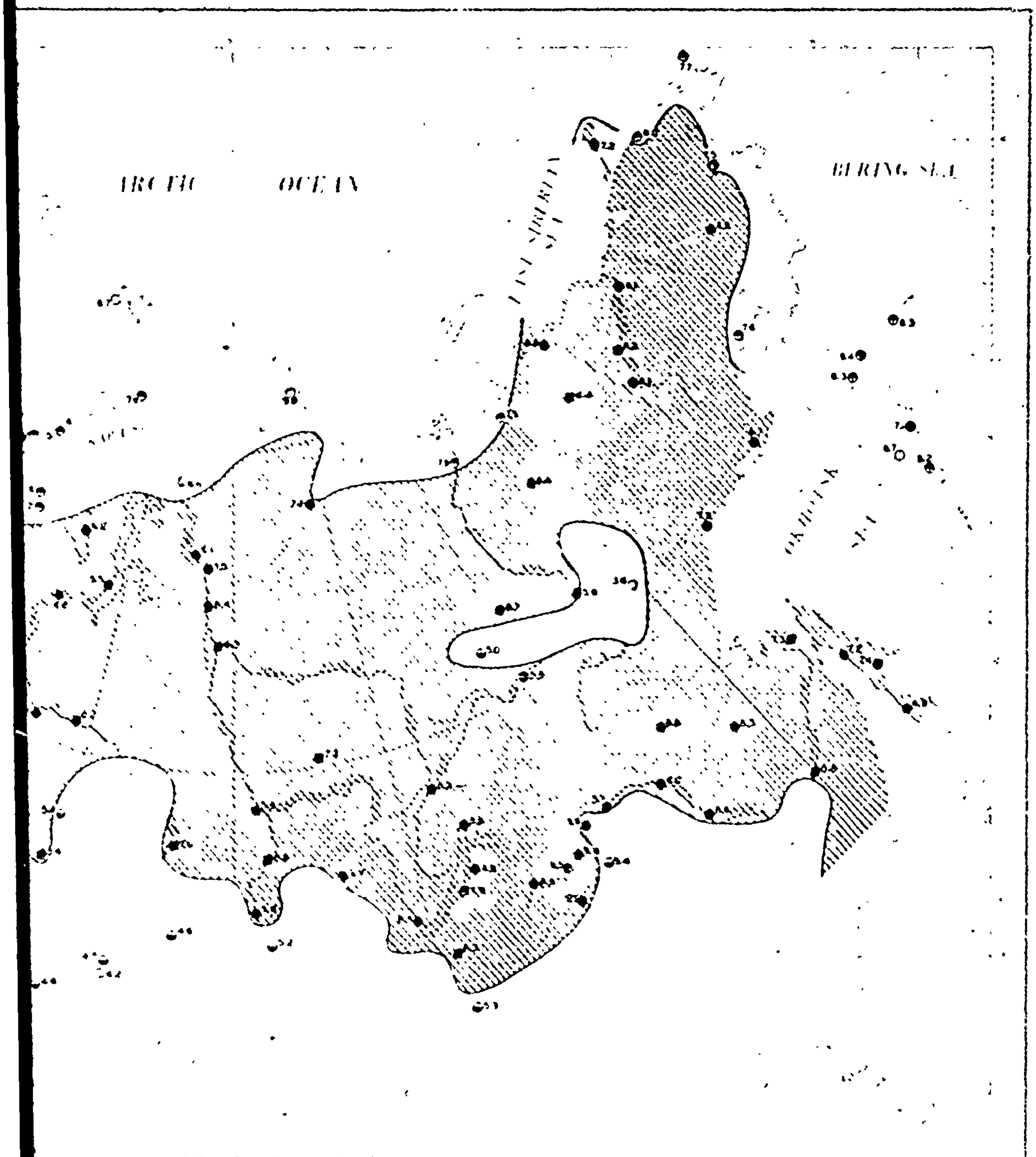

MEAN DAILY MAXIMUM
TEMPERATURE
WARMEST MONTH
FORT GREELY-69 F
FORT CHURCHILL-64 F



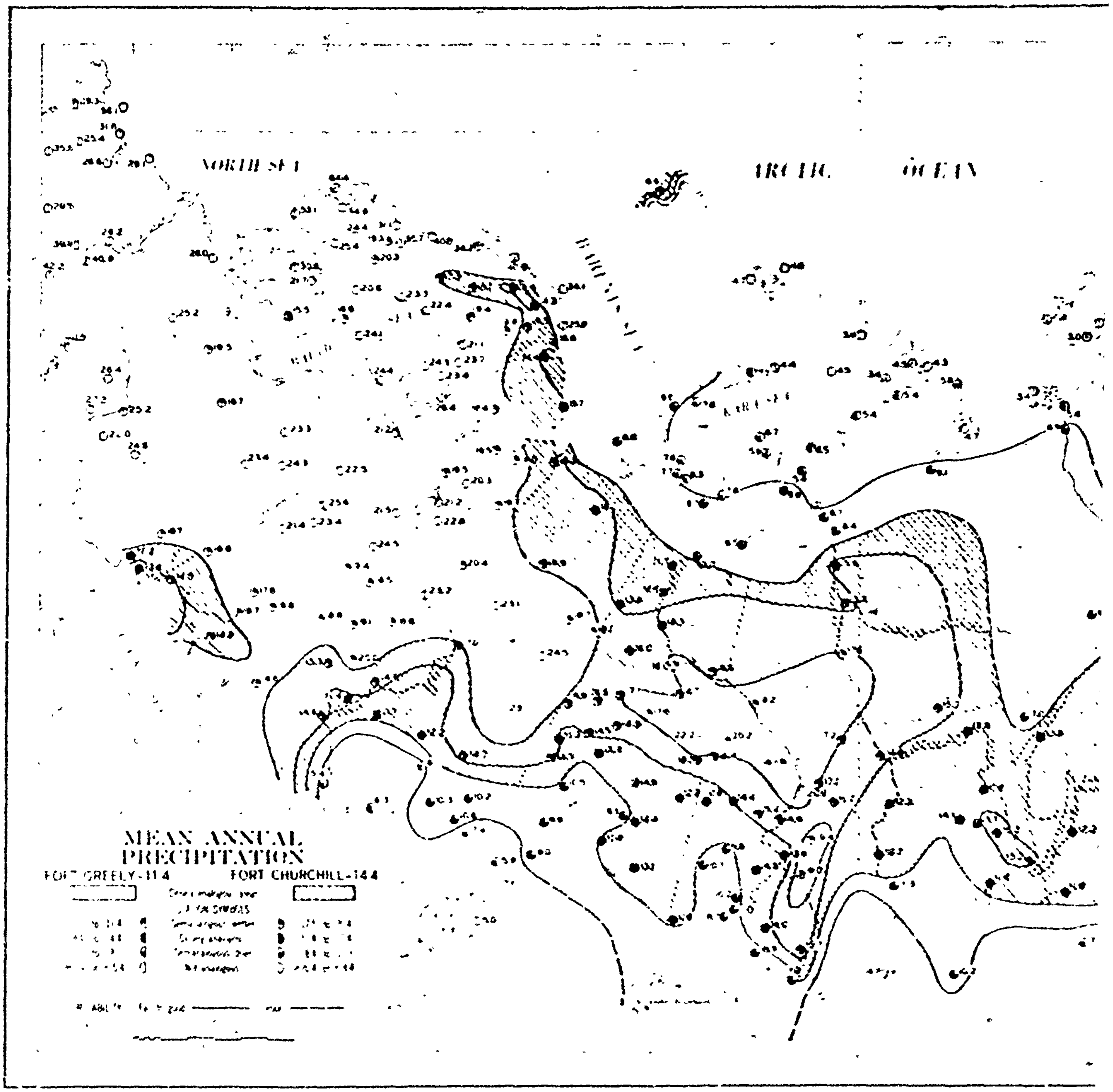
Figure


NORTH SEA
ARCTIC OCEAN
MEAN CLOUDINESS
WARMEST MONTH
FORT GREELY AND FORT CHURCHILL - 6.4 TENTHS

ORT GREELY AND FORT CHURCHILL – EURASIA



CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL



.FELY AND FORT CHURCHILL – EURASIA

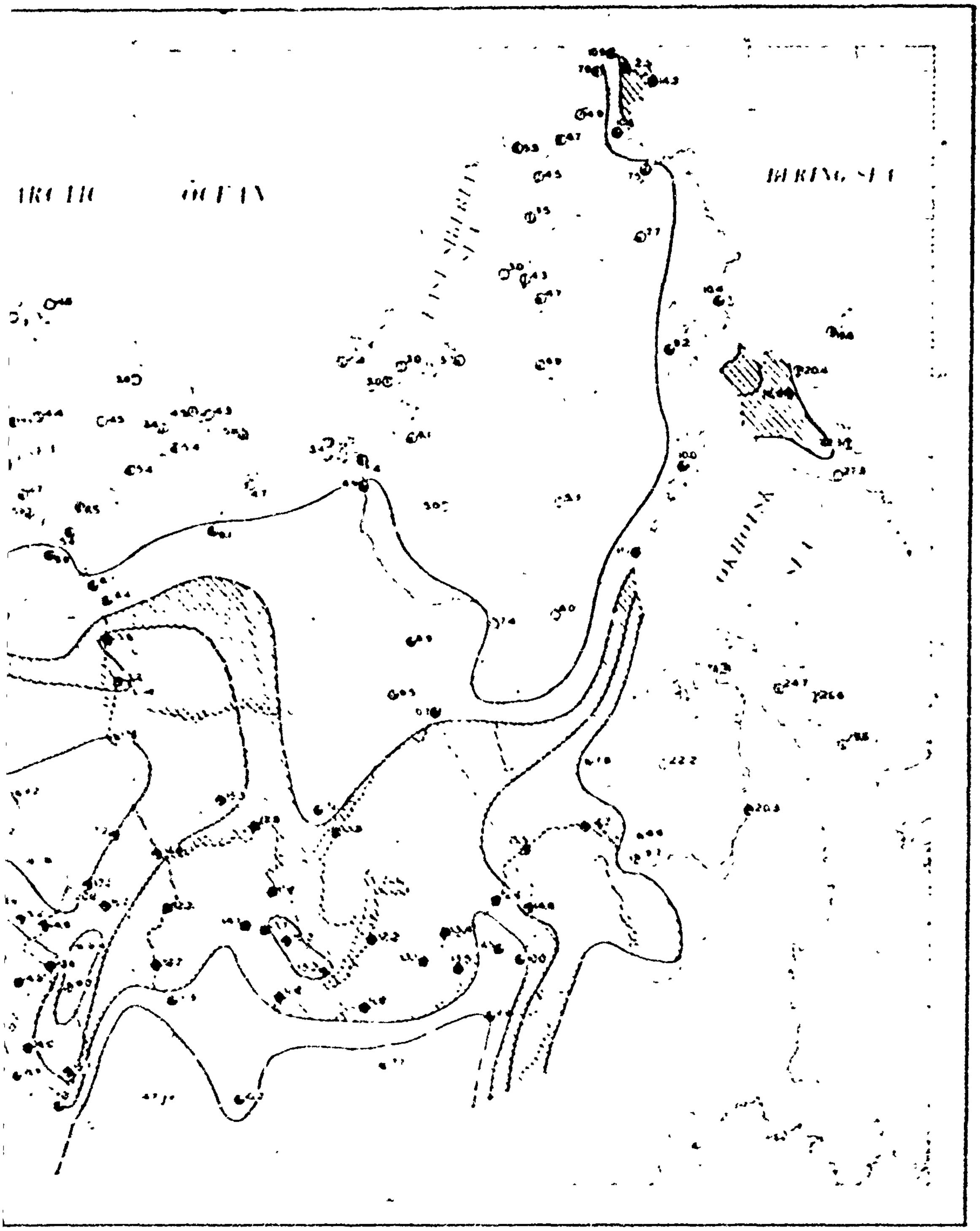
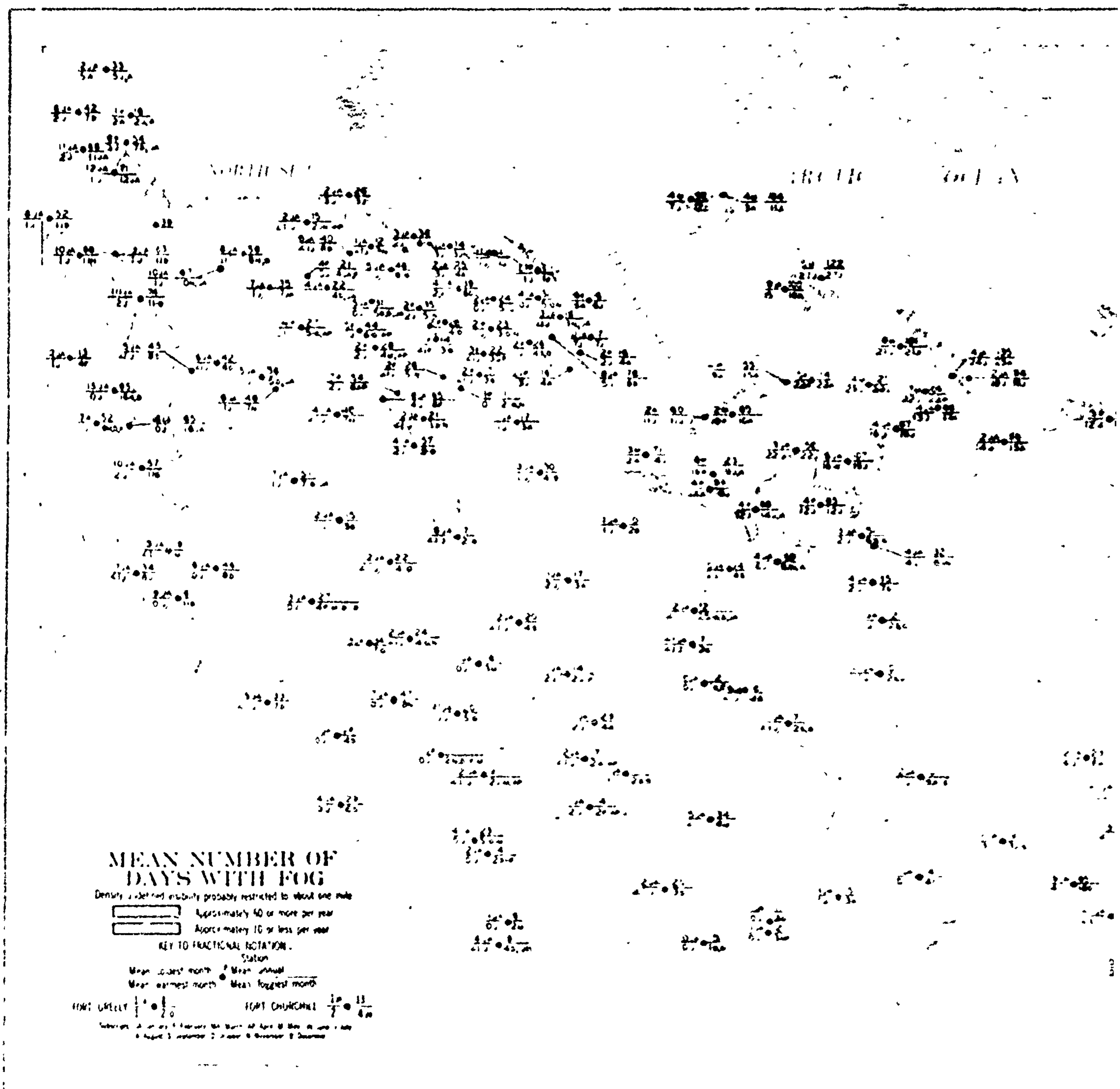


Figure 12

2



MEAN NUMBER OF DAYS WITH FOG
Approximately 60 or more per year
Approximately 10 or less per year
Station
Mean coldest month
Mean annual
Mean warmest month
Mean foggiest month
FORT CHURCHILL

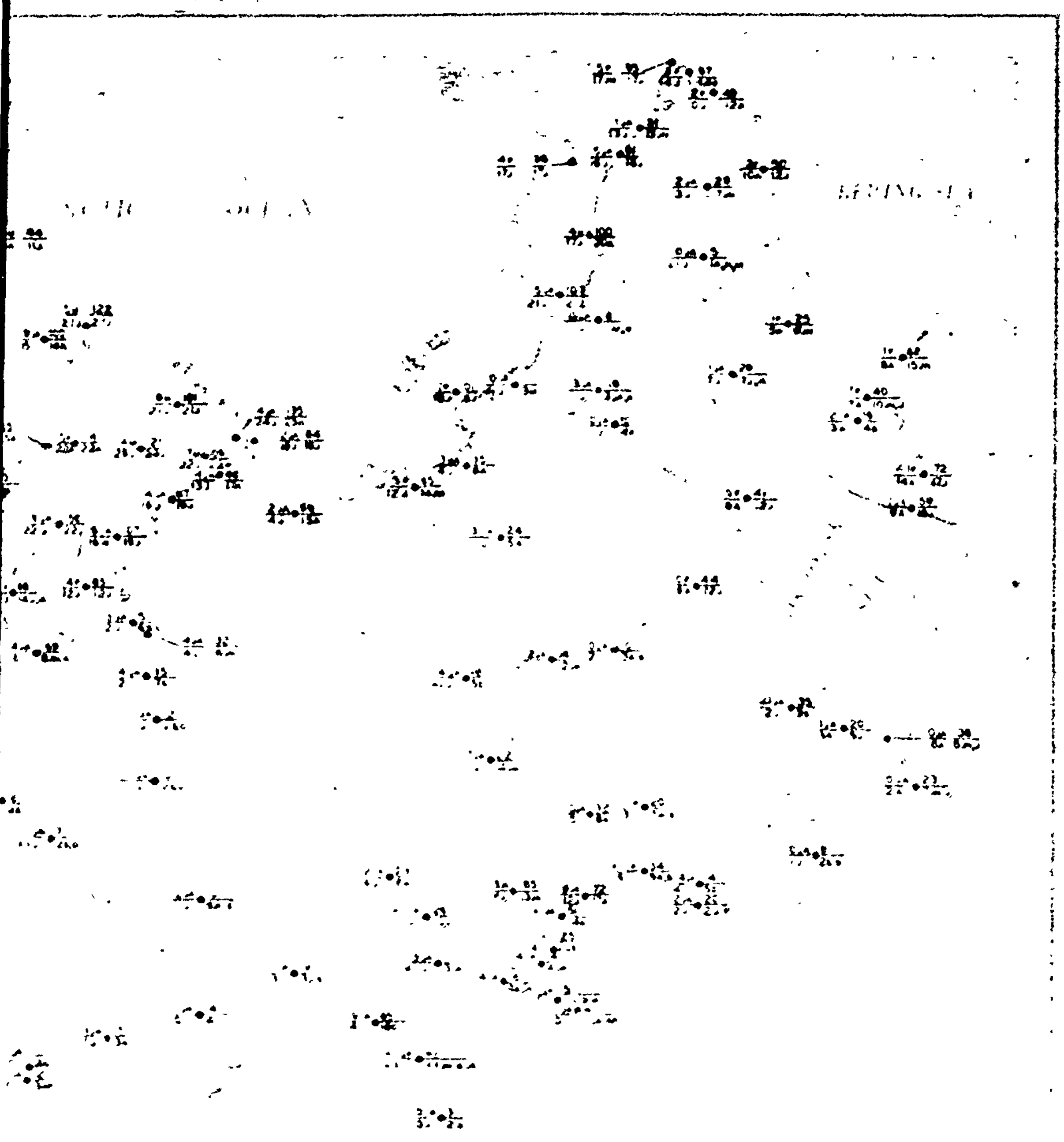
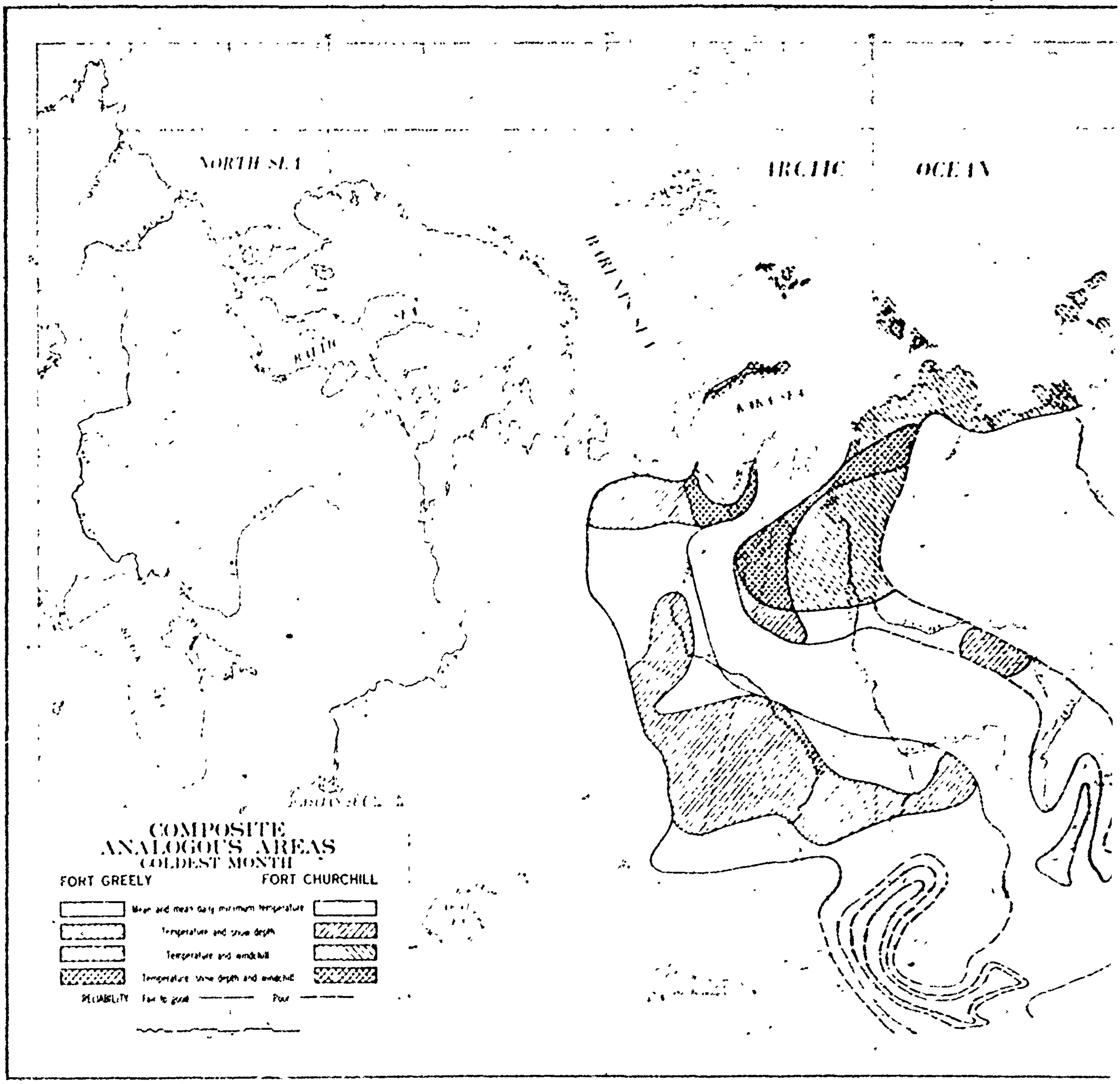


Figure 12A

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL



GREELY AND FORT CHURCHILL – EURASIA

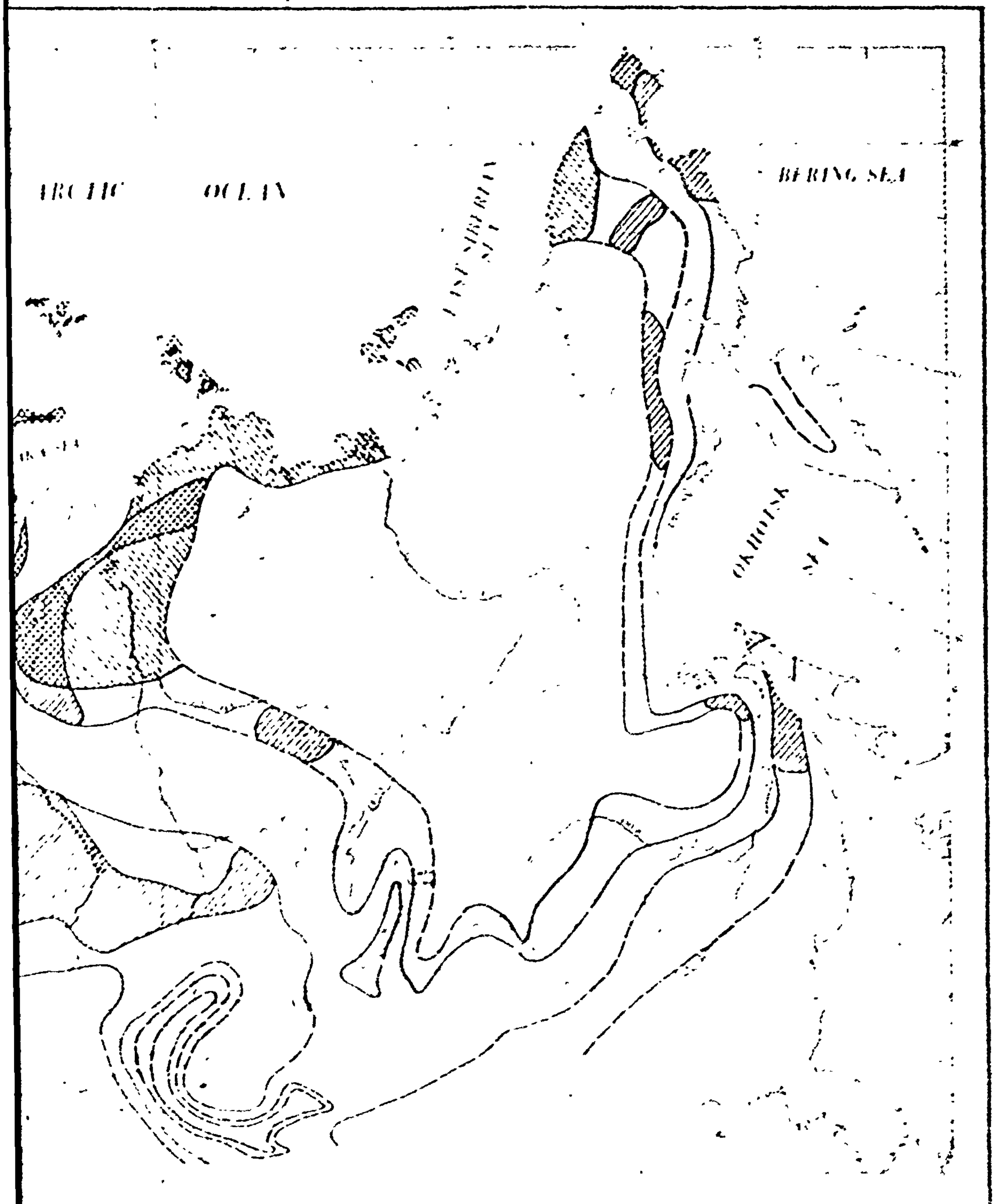
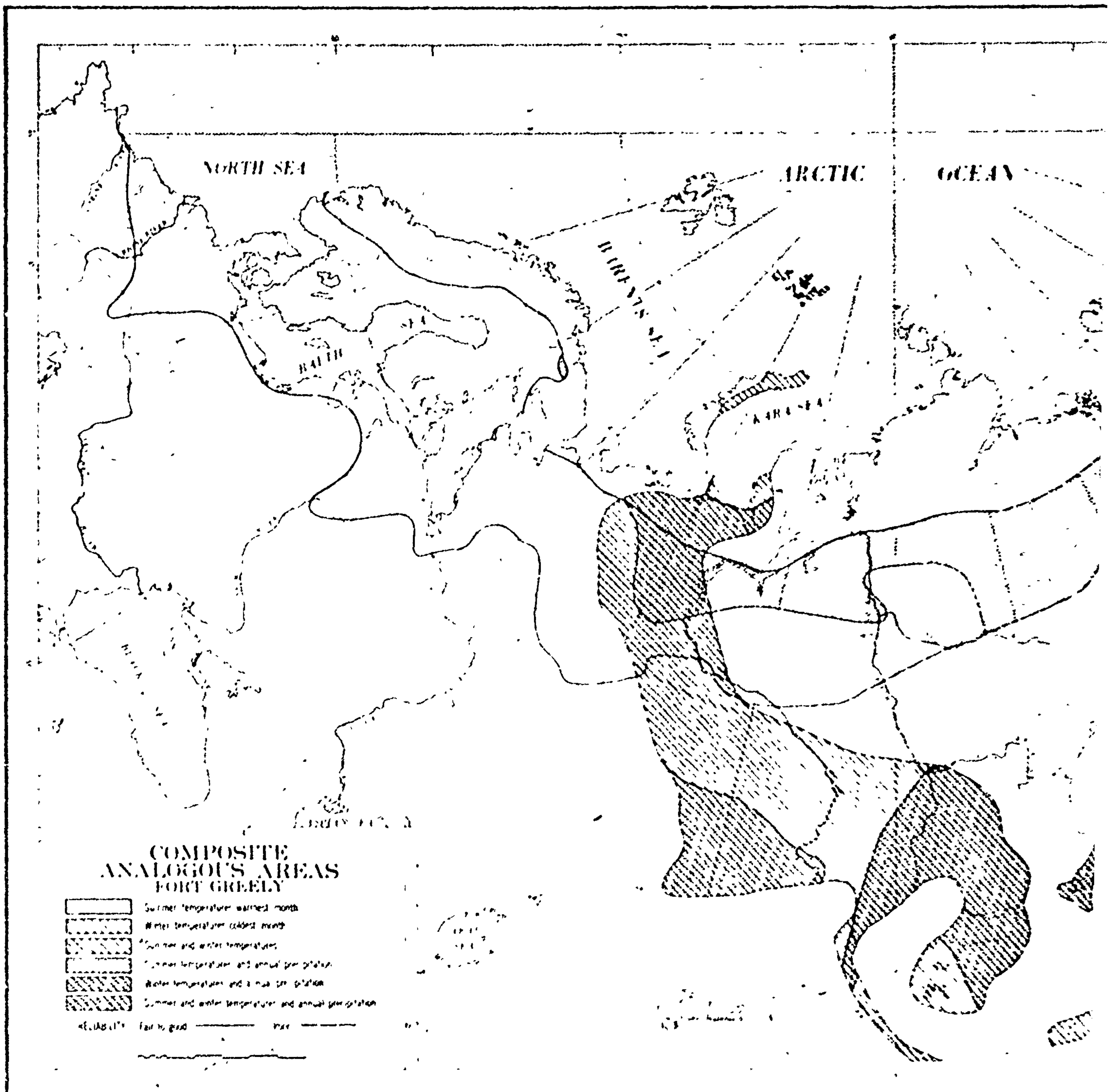


Figure 13

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCH



FORT GREELY AND FORT CHURCHILL – EURASIA

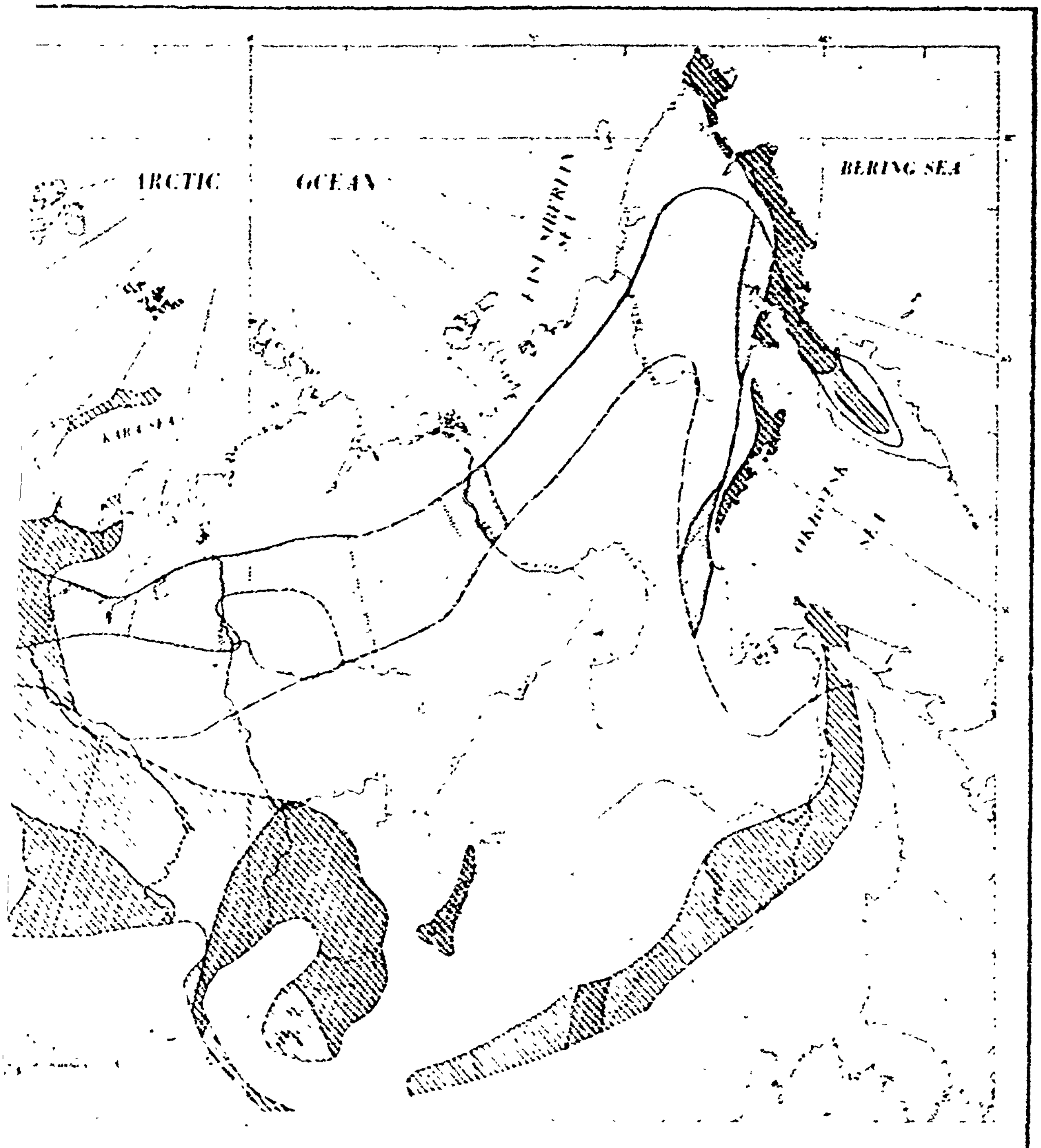
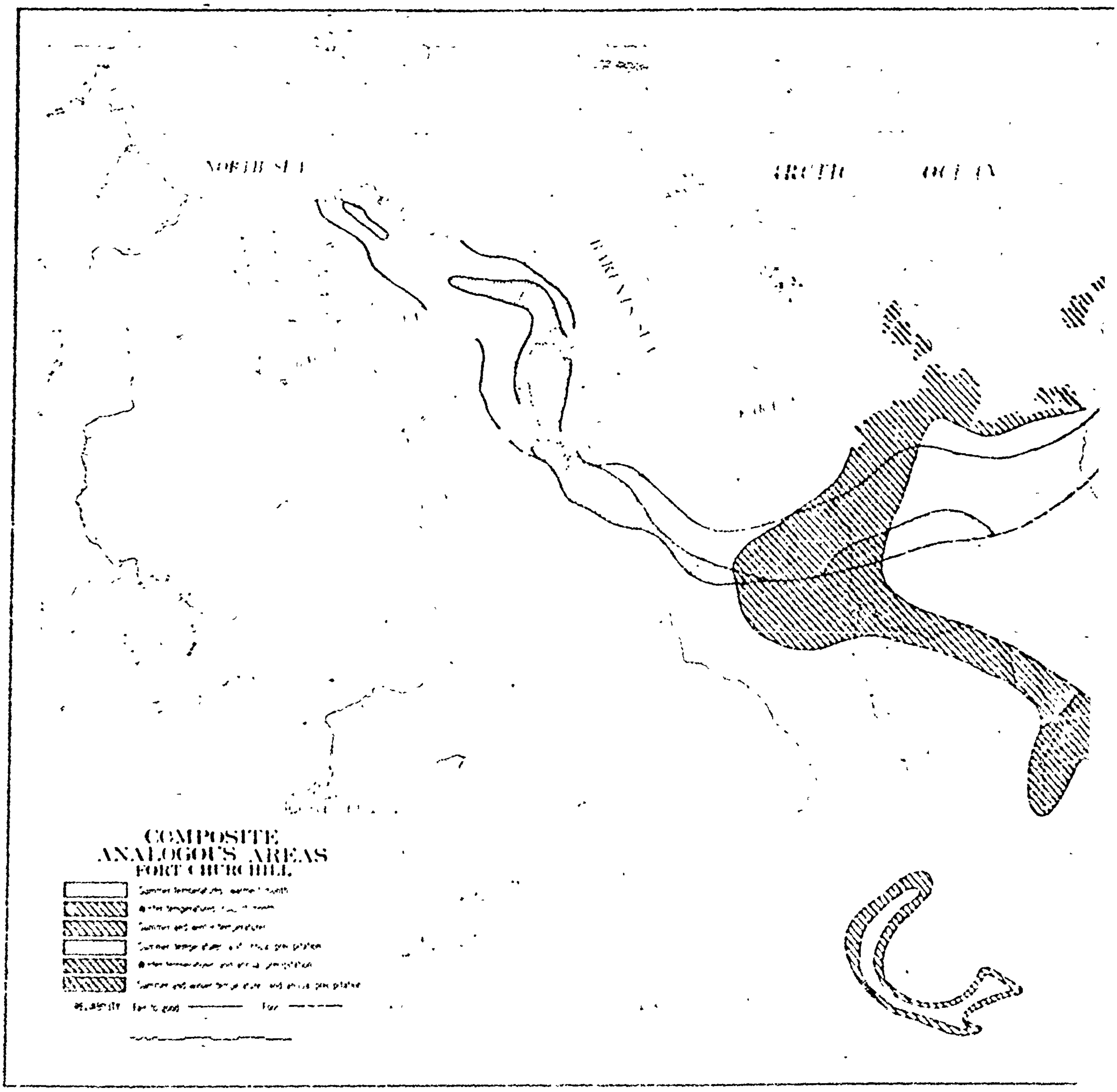
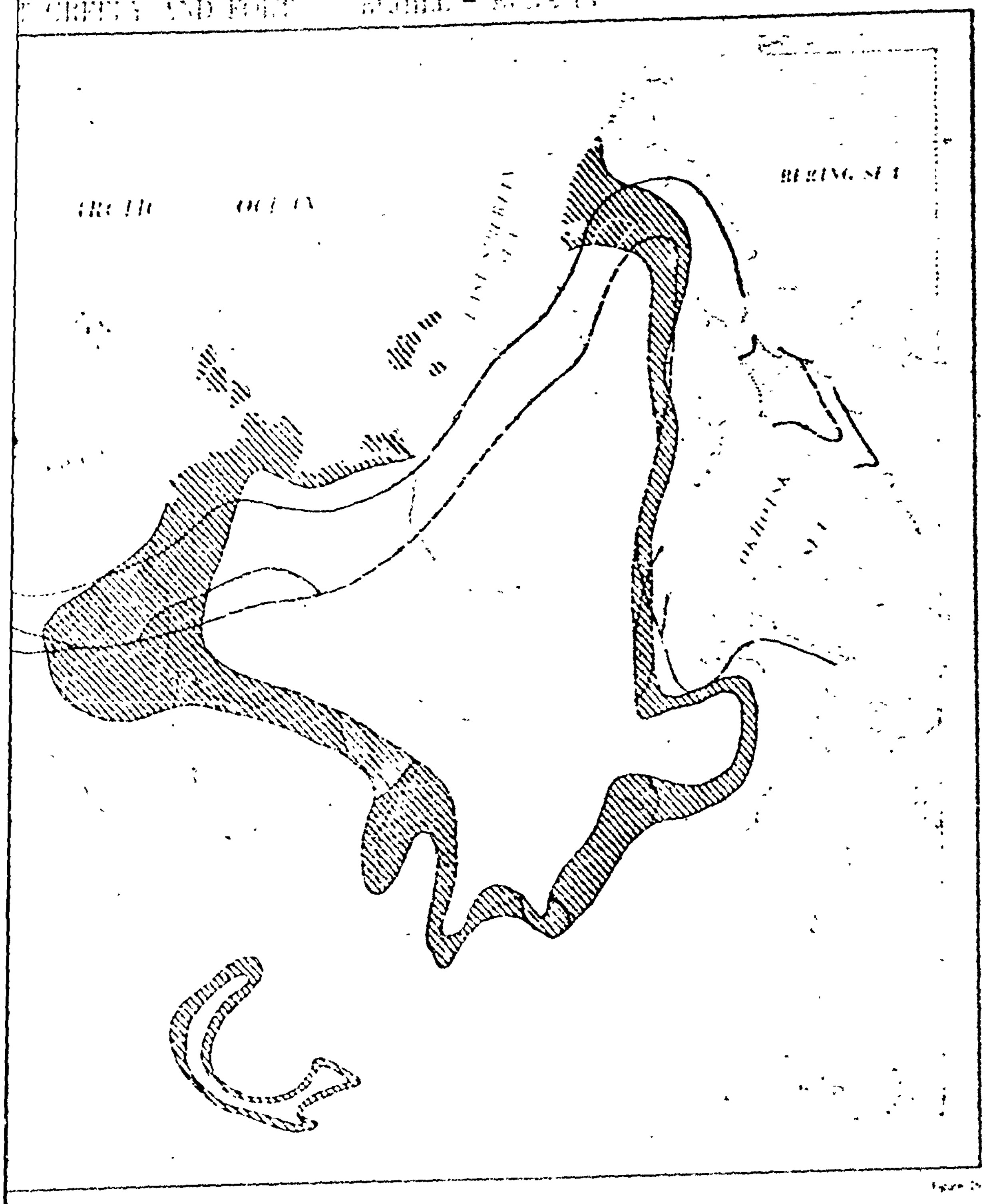


Figure 14

CLIMATIC ANALOGS OF FORT GREELY AND FORT CHURCHILL




BERING SEA